

A Tribute to Bob Pease

Pease Porridge – 3 (1996-1998)

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ON

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On December 6, 2000, PlanetEE will bring you a Webcast with National Semiconductor's renowned analog guru and popular Electronic Design columnist Bob Pease. In typical high-energy style, Bob will present

"What's All This Current-Source Stuff, Anyhow?"

Fans of Bob Pease and his Pease Porridge column don't want to miss out on this opportunity to interact with him. Those unfamiliar with Mr. Pease will be treated to an offbeat, information-packed look at the world of current sources.

For details on how to access the Webcast, go to www.PlanetEE.com and click on the "How To View A PlanetEE Webcast" information link.

PLEASE PORRIDGE



BOB'S MAILBOX

Dear Bob:

I, too, have been around for a number of years and remember buying some of the first "Mesa" transistors from Motorola, which came with individual data sheets! And I was part of the team at Magnavox Research that convinced TI to put a Darlington pair in one package! We also developed redundant flip-flops using four individual transistors in each leg! Great reliability—up to three transistors could fail in each leg (short or open) and they kept on flipping and flopping. The only silicon transistors that could achieve any useful gain 20 MHz (cps) were made by Western Electric, and they were tightly rationed and available for government projects only. Their existence may have been classified "secret." I can only imagine the monstrosity of a PID controller if anyone built them in those days—possibly with vacuum tubes?

Anyway, I went up the ladder from circuit design to management and then to marketing. I'm now somewhat retired, but I still find myself involved in designing circuits for this or that and trying to keep up with the latest technologies. I also work part-time for a local TV shop. This profession paid my way through college and kept "beans on the table" during some rough times in the Aerospace Industry.

My biggest peeve is RELIABILITY. In February of last year, I decided to upgrade my computer from an XT to a faster AT and purchased a new 386DX40 motherboard. This allowed me to install Windows and do a few new things. Last May, I realized my system was overdue for a new Hard Drive, so I purchased and installed a new Quantum 540-Mbyte unit. It failed within a week! Numerous bad sectors with more showing up constantly. The company replaced the drive.

Within the next week, my 386 motherboard stopped accessing the floppy drives! Yes, the problem is definitely on the motherboard. AMD says it's probably a failure in one of the CMOS

chips, but the board was manufactured by "some cheap Japanese or Korean company," so—tough! The board was guaranteed for one year and the company that I purchased it from wouldn't help.

I then purchased a new IBM 486 "Blue Lightning" 75-MHz motherboard. The first one failed during installation. I got an on-screen message, "Battery-Operated Bios is Corrupt!" The dealer replaced the board. The second one worked well for about a week. It then refused to access Com Port 2 (or 3 or 4) and the Parallel Port failed! This is board #3. I didn't have to take it—they would have refunded my money—but it has great features like built-in 32-bit buffers and disk controllers.

I inquired about the quantity of these failures and was told that they had sold 120 of these IBM motherboards to that date, and had only 10 returned as defective, including the two from me! They said this wasn't too bad.

When I purchased my new motherboard, I decided to go "whole-hog" and bought a sound card and CD-ROM drive (from another source because of price). I am now on my second Sony CD-ROM drive and my sound card recently failed. No—my power supply is not the cause of failure.

Apparently there is little consideration for reliability on the part of the manufacturers!

RCA television receivers (this now includes GE) have been plagued over the past few years with AREAS of poor solder adhesion (or lack of sufficient solder). The majority work for a short time, most probably until the warranty expires. Then, when a little oxidation takes place, the connections separate. If you call the factory technical assistance people, the first thing they tell you (as a technician) is to resolder a certain area depending on the model (chassis) number. You would think that after

a few years they would have this problem resolved, but the latest sets are still having the same problem.

Zenith is not to be left out. Both in-warranty and out-of-warranty (exchange) modules and main boards are very unreliable. About one out of two work when first removed from the box and installed in the set! Most technicians don't like to install Zenith modules in the home because of possible embarrassment. Nothing creates a lack of customer confidence faster than installing a "new or rebuilt part" and the set still doesn't work. Ethics doesn't permit you to warn the customer that the "new" part may be bad ahead of time. Besides, if you say that, the customer will have a lack of confidence in the new part even if it does work. Unfortunately, testing the new part prior to installing it in a customer's set is cost-prohibitive.

Both of the above cases are blamed (by some) on "off-shore" manufacturing origin. Even if this is true, why isn't something done to correct it? The Quality and Reliability reflect on the manufacturer, in this case "American companies." The majority of consumers are unaware that RCA, GE, and now Zenith televisions are manufactured by foreign-held companies.

Magnavox redesigned their switching power supplies in their TV sets (which includes Sylvania and Philco) at least five times over a several-year period. The new ones are still the most common cause of set failure. They also had some solder problems, but nothing like RCA and GE.

It appears that the sets with "American names," including Emerson, Symphonic, etc., have more problems than those with names like Sony, Hitachi, Mitsubishi, Sharp, etc. Surely Reliability can't be in the name?

Now, I believe that I have beaten this to death on, I am sure, sympathetic ears. I really don't expect a reply, but feel free to comment on any of my criticisms. These are the FACTS and may be verified very easily.



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READER SERVICE 129

PEASE PORRIDGE

ROBERT N. (BOB) ELLIS
Chestertown, Md.

Yes, in the OLDEN days we designed PID controllers with 0.1- μ F polystyrene caps and K2-X op amps. The offset stability of 8 mV per day was not disastrously bad, given the ± 100 -V full scale. If I wanted to, I could easily have built that Nov. 20 Ball-on-Beam Balancer using tubes. It would not have been less reliable than the computer boards you listed. I don't buy many new computers; I wait until somebody else has got them to a point of proven reliability. Hey, Bob, have you written to the manufacturers of those boards to complain? All you guys out there better complain when somebody starts selling you unreliable junk.—RAP

Dear Bob:

As a hobby and part-time job, I repair business telephone equipment. Now, I understand that repair is generally deemed too lowly an activity for a design engineer to engage in, but it helps pay the mortgage and lets my wife stay home with the kids. I figure that bringing up a couple of old-fashioned, well-adjusted offspring is worth a bit of my dignity. (On the positive side, it's really helped sharpen my troubleshooting skills.)

At any rate, as telephone models changed, about 20 outdated telephone power supplies became stranded in my garage. After a few years of residence in my garage, I decided to get rid of them by disassembling and RECYCLING them. On a Saturday morning, my father-in-law and I took our power drivers and reduced the stack of equipment, which weighed just over half a ton, into separate stacks of steel, aluminum, transformers, and a few worthless electrical components.

Having been through this exercise, I am keenly aware that electronic equipment does not lend itself for recycling. Is there anything we can do as designers of electronic equipment to make reuse or recycling of parts easier? Or, is the electronics industry such a small drain on resources that it is insignificant?

LES WOLFF, P.E.
*Pelican Harbor Engineering
Santa Barbara, Calif.*

Les, dismantling power supplies down to the copper, iron, and aluminum is cost-effective only for a BIG recycler. Why not sell the supplies to a SURPLUS shop, and when a guy wants a transformer or whatever parts are in there, let him dismantle what he wants? We have many surplus stores in the Bay Area, such as Ace, Halted, Haltek, and the Electronics Flea Market at Foothill College in Los Altos (2nd Saturday of each month from April to September, 6 A.M. to noon).—RAP

Dear Mr. Pease:

In a letter printed in your June 26, 1995 column, Mr. Philip C. Todd commented on Design Quality. He made many good points, but he left a large portion out of his "Design Objective" equation.

Mr. Todd stated that "...the objective of the design process is to minimize the total dollars spent over the life of the product." I believe that this is only half of the objective, the other half being to maximize the dollars produced while minimizing the total dollars spent.

It's relatively easy to produce a design that minimizes "...the design cost, the manufacturing cost, the product support cost, the disposal cost, and the liability cost." The hard part is to develop a design that meets these criteria and that customers are willing to pay good money for.

HAL G. HANSON
*Senior Design Engineer
Philips Semiconductors
Albuquerque, N.M.*

Hi, Hal. If we said "All things being equal," then low development cost would be advantageous. Low production costs and low warranty costs are nice, too. But since things ain't EVER equal, features that will please customers also are, of course, important.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:
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National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

WHAT'S ALL THIS PICOFARAD STUFF, ANYHOW?

There are lots of places where a little capacitance can cause problems. Even a picofarad can cause significant problems. (We do not really say, "picofarads," nor do we use the 6-syllable word, pi-co-fa-rad-u-zu, as the Japanese like to pronounce it, but just, "pufs.") For example, if you have a signal with a high source impedance, even 1 pF can slow down the response. Similarly, if you have a current-sensing amplifier using an op amp with a Feedback Resistor of 10 MΩ, even 1 pF of feedback capacitance can slow down your amplifier's response a lot—as slow as 10 µs (time-frame) or 100 kradians/s, or 15.9 kHz. Not blindingly fast.

On the other hand, if you don't even have 1/5 pF of feedback capacitance, then that amplifier will probably be unstable. It might oscillate, or ring like a bell. So it's important for you to know how much capacitance is going into your circuit. You do NOT want to go out and buy a 1/2-pF capacitor. But you can easily build as



BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCTOR CORP.,
SANTA CLARA,
CALIF.

much capacitance as you want into your printed-circuit board layout, if you think about it. If you want 0.5 pF between the output and input of an amplifier, you can place two pc foil runs side-by-side for 0.7 in. to get 0.5 pF. Of course, if you do NOT want 0.5 pF, but you run the pc foils

side-by-side for 0.7 in., you still get the 0.5 pF. If you wanted to decrease the capacitance, you might put a grounded foil run between them.

Thus, I decided to present a photo essay of several items that make a picofarad. I made up some little capacitors and measured them. Then I figured out how much of that material or geometry is worth 1 pF, and I marked off an amount equal to that—and took a picture. Then I made up the captions to fit the photos. Note: I didn't LITERALLY measure the capacitance of 0.82 in. of coax cable, or the actual capacitance of 1 cm × 1 cm of a 0.8-mm-spaced parallel-plate capacitor. I measured a foot of that cable, and then did a proportion. I am NOT going to worry about the fringing of a little 1-cm-square capacitor.

Let's start with the Parallel Plate Capacitor. I show 1-cm square × 0.88-mm spacing—that's 1 pF. I went into several Handbooks of Electronics to find the formula for the capacitance of a parallel-plate capacitor. I had a heck of a struggle. First, I looked into *The Electronics Engineer's Reference Book*, (Butterworths, 1989). I waded through a couple dozen pages of facts about capacitors, but got nothing better than the truism that one farad is the capacitor you have if one coulomb (that's an ampere flowing for 1 second) changes the voltage by a volt. That's a big help. Then I tried McGraw-Hill's *Electronics Engineers' Handbook*, which said that the capacitance of two parallel plates of area (s) and spacing (l), ignoring fringing, is:

$$C = \epsilon \times s/l$$

Then they expanded to say that:

$$\epsilon = \epsilon_0 \times \epsilon_r$$

I searched all over the book, and

the most satisfaction I got was that:

$$\Gamma_e = 10^7 / 4\pi c^2$$

where c is the speed of light. That didn't reassure me I would be able to

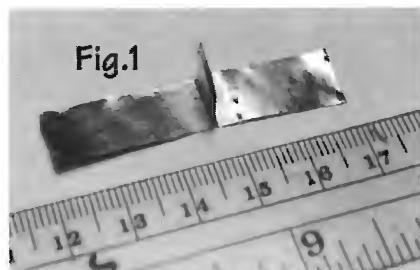


Fig. 1



Fig. 2



Fig. 3

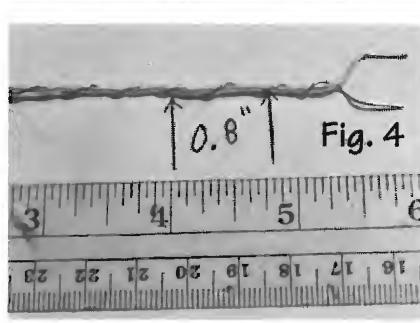


Fig. 4

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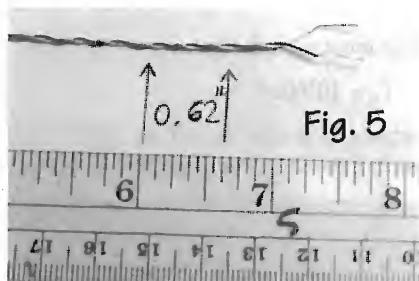


Fig. 5

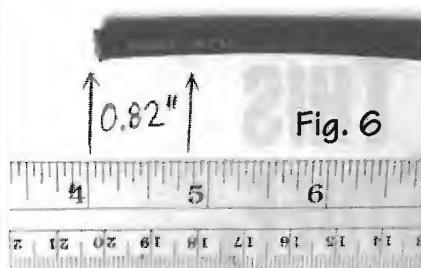


Fig. 6

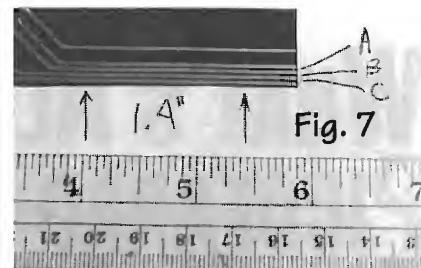


Fig. 7

estimate the capacitance of a couple of parallel plates.

Finally, I dug out my trusty old CRC (Chemical Rubber Company) *Handbook of Chemistry and Physics*, which I bought as a student back in 1959. It states that the Capacitance of a parallel-plate condenser of area A and dielectric constant K and distance d is:

$$C = KA/4\pi d$$

HOWEVER, if the dimensions are in centimeters, the capacitance is given in electrostatic units. What the heck is "an electrostatic unit?" I went over to page 3183 to read that "one statfarad" or "one centimeter" is an electrostatic unit equal to 1.11263×10^{-21} abfarads (the "abfarad" is an "electromagnetic centimeter-gram-second, or cgs, unit") and also is equal to 1.11263×10^{-12} farads. OKAY—one "electrostatic unit" is 1.11263 pF . Then, by substitution, the capacitance in picofarads of that same parallel-plate capacitor (dimensions in cm) is:

$$C = 1.11263 KA/4\pi d, \text{ or}$$

$$C = 0.08854 KA/d$$

with the answer now in picofarads.

Specifically, an ideal parallel-plate capacitor of a centimeter cube is about $1/11.3 \text{ pF}$. So the capacitor 1-cm square with $1/11.3\text{-cm}$ spacing is about 1 pF . I am taking all of these equations

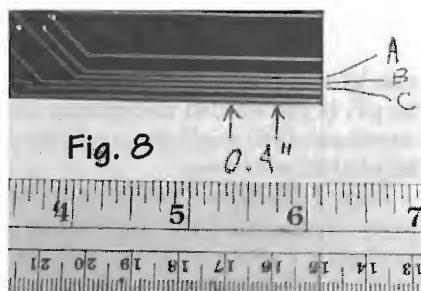


Fig. 8

and gluing them into all three books to save me grief in the future. Finally, I struggled over to page 2524 to find the dielectric constant (K) of air, where $K = 1.000000$ for a vacuum. The K for air is around 1.000537 , with a minor dependence on the air's temperature and pressure. For most cases, that's not much different from 1. I can, however, observe that some "air-dielectric" capacitors have ceramic supports that can contribute significantly to the dielectric absorption and tempco.... more on that later.

So—Figure 1 shows a small parallel-plate capacitor, full of air, 1 cm \times 1 cm, with about 1/11-cm spacing. This is about 1 pF . Of course, the spacing isn't exactly 0.88 mm, but this picture represents 1 pF .

Now look at Figure 2. It's a small baby-food jar—about $1/4$ square inch of this will be 1 pF . (This is in honor of the original Leyden jar—the world's first capacitor.) The total capacitance is about 55 pF .

Figure 3 shows a Silk thread—20 strands here at 2.5 inches. However, about 600 strands 2-in. long = 1 pF . Silk thread was one of the world's first insulators. About 100 years ago, scientists used several strands of silk thread to support objects without adding capacitance or leakage, and it still works pretty good today.

Now let's talk about twisted-pair capacitors. A trim capacitor made of a twisted pair is called a "gimmick" capacitor. In years gone by, ham-radio operators frequently used them, progressively unwinding and snipping the twisted pair until they got the "right" capacitance. But you have to be careful about what kind of wire you use. For example, ordinary 24-gauge Teflon wire doesn't easily stay where it is bent, and isn't recommended for making trims. On the other hand, 24-gauge plastic wire (the kind you can salvage from pieces of telephone wiring) *does* stay where you put it, and this is good for trimming things.

The twisted pair in Figure 4 consists of one piece of #20 bus wire wrapped around a second piece of this same bus wire in Teflon Sleeving—about 0.8 in./pF and reasonably stable. Figure 5 is a twisted pair made out of 28-gauge wire-wrap wire. About 0.625 in. will give you 1 pF .

Then there's Coax Cable. Many types are available, and depending on the cable properties (impedance, di-

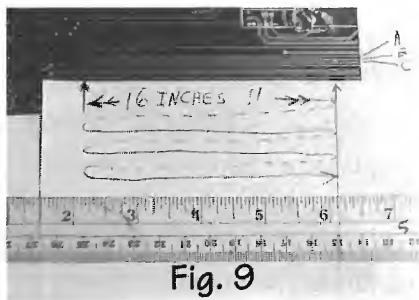


Fig. 9



Fig. 10

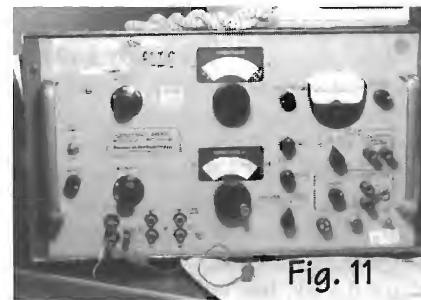


Fig. 11

POWER DIET PLATE

*Actual Dimensions:
1.5" x 3" x .375"
Weight: 3.75 oz.*



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electric, etc.), they'll exhibit differing amounts of picofarads per foot. Figure 6 shows that you can get 1 pF with about 0.82 in. of RG62 cable.

Don't forget that resistors are capacitors, too. Four Allen-Bradley 1/4-W Carbon Composition types wired in parallel have about 1 pF (1/4-pF each). It takes five inexpensive 5% film resistors to get 1 pF, or six RN55D-type, inexpensive 1% metal film resistors. Now, if you're dealing with a 10- Ω resistor, you obviously don't have to worry about its capacitance. But, as I mentioned at the start of this column, you can't necessarily neglect the capacitance across a 10-M Ω resistor. So stay *aware* at all times.

Let's talk about printed-circuit boards. Refer to Figure 7 for the capacitance between two adjacent foil runs (A to B)—1.4 in./pF. (Board thickness is 1/16-in., double-sided, G-4 Fiberglas-epoxy, and the reverse-side ground plane is grounded.) Figure 8 is the same pc board—capacitance from ONE foil run to ground as well as to both adjacent foils (B to A and C and Ground plane)—about 0.4 in./pF. Figure 9 illustrates the transcapacitance (cross-talk) from one foil run to a guarded run two runs away (capacitance from A to C, with B grounded)—about 16 in./pF. Figure 10 shows a group of eight supports made of copper-clad. Each one is 1/8 pF.

In all of the previous examples, each of these capacitors is compared to an inch-and-centimeters ruler for the benefit of those who work outside of the U.S. Some items have capacitance that can't be measured by the inch. Here's a few examples:

One 1N914 diode at a reverse bias of 2.0 V = 1 pF. A wire-wrap socket has about 0.5 pF per pin-pair, or 1 pF from pin 2 to pins 1 and 3. But a socket with shorter pins has 0.3 pF per pin-pair, 40% less capacitance. A little DPDT switch has only 0.6 pF from one common to either of the switched throws, when you switch it OFF. But the capacitance from one pole to all the elements on the other POLE was about 1 pF, on the example we measured. An ordinary nylon banana jack, in a chassis, was about 2.1 pF, and a teflon BNC connector in a chassis was about 2.0 pF.

Finally, I compute that the capaci-

tance from the Earth to the moon is about 120 μF . I debated with several people on how to measure this capacitance. If you sat on a rocket 10,000 miles above the North Pole of the Earth and lowered a LONG wire down to the North Pole, and likewise shot a long wire to the moon, one could, *in concept*, measure the 120 μF . But actually, the wire would break, and besides, it would be VERY EXPENSIVE to set up a space station that's NOT IN ORBIT. One guy said to just set up an LM555 timer with 1 $\text{M}\Omega$, and look for the time constant. Great idea. Maybe we could measure the voltage of the moon and then send up 120 microcoulombs of charge and see if the voltage changes by a volt. But I don't think you could get that charge up there without the charge leaking off. So I guess we'll just have to believe the theoretical calculations....

What did I use to make these capacitance measurements? An old Boonton Bridge with dials, model 75A-S8 shown in Figure 11. It has good resolution, and pretty good accuracy. It's capable of making 3-terminal measurements—the capacitance from A to B allowing for the guarding actions of ground, and not counting any capacitance from A to ground or from B to ground. Many nice "C-meters" won't do that. I asked Mineo Yamatake if that Boonton was around when I arrived at NSC 20 years ago. He said it was here before *he* arrived here, 29 years ago. Some of the oldest machines are some of the best.

Meanwhile, you have to consider these capacitances I have represented as rough estimates, ball-park estimates. Not all switches will have the same capacitance. Different kinds of cable have somewhat different capacitances. Still, these pictures will put you in the right ballpark. If you want to know, measure it yourself.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:

Address:
Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

PEASE PORRIDGE



BOB'S MAILBOX

Dear Bob:

Re: "What's All This Carpal-Tunnel Stuff, Anyhow?" that appeared in the Sept. 5, 1995 issue of *Electronic Design*. If memory serves me correctly, I think I wrote you once before and mentioned the Dvorak Simplified Keyboard (DSK). Perhaps therein was mention of Carpal Tunnel Syndrome (CTS), and the easing of much strain and pain that can accrue for those who continue to use QWERTY keyboards.

Some high-end keyboard users never seem to be bothered with CTS; others become almost paralyzed with it—my eldest daughter is a case in point. She was taught the use of the Dvorak Simplified Keyboard in high school at my insistence and the teacher's okay. But when she applied for work at State Farm Insurance Co., she had to relearn and use an old QWERTY keyboard. Today, she is living on workman's compensation while her case is being reviewed, as insurance companies are far more aggressive in harvesting money than paying it out for workers who succumb to the dangers of the workplace.

You will find "studies" of fairly recent date which declare that there is very little to be gained by using the DSK board over the QWERTY keyboard; but those few of us who adopted it early on know better. Of course, one should look for the variables which were not addressed in these studies, such as what posture the typist uses, whether the wrists form a straight line with the arms during typing, and whether the typist is permitted to rest for five or ten minutes during each hour.

I invite you to walk through the offices of your present company and observe the typists at work. How many have a straight-line posture for wrists and arms, compared to how many are resting their wrists on the near edge of the keyboard while straining to reach from the top row

of keys with their finger pads, instead of having their fingers curled over the home row, such that finger tips touch the keys?

While on your inspection trip, keep a mental column of those typists with long fingernails that can't possibly be used for tapping keys. Then ask yourself, is it any wonder that Carpal Tunnel Syndrome is increasing across the industrial landscape?

Imagine the friction that must take place in the carpal tunnel as the cords to the fingers rub on its inner periphery in response to a bend at the wrist. Makes one wish there was a way to install ball-bearings at each bend, as with a derrick cable in its pulley.

You are certainly correct in your suggestions about resting. But while the cause and effect is very clear to you and me, most typists haven't the faintest idea about how and why their lordotic curves become inflamed and their wrists just can't take it any more. And while the workplace supervisors look upon their workers as just a bunch of androids, there will continue to be no improvement whatsoever in the situation.

A permanent "cure" for these and many other ills in today's working conditions will only come from the heart, and large corporations today do not have hearts. There must come a time, and not too far in the future, when a worker will receive a small minimum wage, plus a fair share of the corporate profits. Then will come education, personal exercise of responsibility as separated from but recognizing individual obligation, and work for the joy of working.

You expressed it nicely in your opening paragraph: "...Personally, I always enjoyed building things and installing the resistors and bending the leads exactly right..." There is a statement by the founder of the Baha'i Faith that fits very nicely here: "Work done in the spirit of

service is raised to the rank of worship." We as a society must learn what the professional engineer knows. Working at a job solely for a periodic paycheck will make an old man out of you in quick time.

Sorry to disagree with you about wrist-pads for typists. That is precisely the WRONG way to go! Instead, raise the wrists until they are in line with the arms, curl the fingers into parallel question marks above the home row, tap the keys with the ENDS of the fingers with neatly trimmed fingernails, and then when this becomes a learned response, take the obvious next step.

Contact Key-Tronics company for a quotation on the cost for an American Alternate Standard Keyboard (the computer-successor to the original Dvorak Simplified Keyboard that was originally applied to typewriters). Mine cost just over \$100 years ago, and worth every penny many times over.

And if \$100 is too much to swallow, there are free programs on a number of bulletin board systems that will redirect your QWERTY keyboard to assume the DSK configuration. If you MUST look at the keys to type, you'll have to pull the key tops off and replace them in the DSK pattern. Otherwise, ignore what the key tops "say" and just touch-type with the new posture and Dvorak Simplified Keyboard arrangement. Goodbye Carpal Tunnel Syndrome.

WALDO T. BOYD, Prop.
Creative Writing PTY
Geyserville, Calif.

Well—Walt—some doctors prescribe wrist pads for distress caused by Carpal Tunnel Syndrome. Some patients agree that is helpful. If the doctors are partly wrong—well—thanks for suggesting that we Question Authority.—RAP

Dear Mr. Pease:

I've been reading your articles for some time, and take great pleasure from them. Having written technical



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PEASE PORRIDGE

articles and a technical question and answer column for DACS.DOC, the newsletter of the Danbury Area Computer Society, it cheers me to see your style get to print. It is more customary to see the editorial types wanting to play to the least common denominator, and God forbid you actually ask anyone to think!

I'm writing because of your Carpal Tunnel Syndrome article in the Sept. 5, 1995 issue. I have been doing a lot of consulting in the assistive technology area for the last few years, and it is a much more common problem than most think. Most of my work has to do with extreme handicapped conditions, where we are either using a computer to generate communications with as little as an eye blink for an input, or going the other way for those with voice capabilities and no movement.

I had occasion to experience it myself a few years back. I was designing a set of mask geometries for the setup and testing of automated mask inspection systems. (You may be familiar with KLA Instruments in San Jose, formally in Santa Clara.)

What caused the problem wasn't typing, but the constant use of a mouse. At the time, I was doing a lot of typing as well as Computer Aided Design work, and had found a very simple solution to the strain from typing. I put the keyboard on my lap (what's left of it after years of flying a desk). For obvious reasons, that solution isn't applicable to a mouse, and the angle one works at on a desktop seems to be more of a problem than the gripping of the mouse.

What I ended up doing was designing a board that slips into the handle of the top right drawer of my desk and put a mouse pad there. I also took the center drawer out of my desk and replaced it with a keyboard drawer (I was running out of lap). My monitor sits right on the center of my desk, instead of on top of the low profile desktop computer, and the neck strain went west.

What all this relates to is that while you are correct in pointing to professional help and *stop what you're doing if it hurts*, the solutions are often too simple to be noted by the medical professionals. I'm sure

you're familiar with the old wheeze "Doctor, it hurts if I raise my arm to here, what should I do?" It is a rare doctor that will say, "Don't raise your arm that high." In the areas of repetitive stress, that is often the key to solving the problem. It has little or nothing to do with how sturdy the individual is (I'm built similar to a bear and can press over 200 lbs.), but the angles we do things at.

While the placements that worked for me fixed the problems I was having, my wife needs her monitor 5-in. off her desktop, or she gets stress headaches. Each individual needs to have their "workstation" customized to their most comfortable arrangement of components. In the workplace, that is often at odds with the need for uniformity that some management types feel compelled to enforce.

Those assemblers you spoke of in your article who became injured by the repetitive stress were working at the same bench height as everyone else. In some cases, it might have only required as simple a move as changing the seat adjustment a couple of inches.

I'm not a medical doctor either, but the pain that tells someone they are doing something wrong can be the best indicator in finding the individual's solution. It simply takes a realization that there is more than one way or position to do something, and the courage to try doing it differently. Otherwise, if you want to go through life saying "MOO," don't complain that the milk maid's hands are cold!

JOE GIANGARRA

Thor Designs

West Cornwall, Ct.

Joe, thanks for your comments. It's those little angles and inches that can make the difference between a comfortable workplace and devastating pain. —RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:

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National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

WHAT'S ALL THIS CAFFEINE STUFF, ANYHOW?

Once upon a time, about 200 years ago, there was an Industrial Revolution. Of course, they didn't exactly call it that at the time, but that's what it turned out to be. Instead of every housewife carding her wool by hand, spinning her wool into yarn on her spinning wheel, and weaving the yarn into cloth on her loom in her home, a lot of people went to work in a mill, where machines did a lot of the work faster and more efficiently. Arkwright's Spinning Jenny made a finer, more consistent yarn than any housewife could do. Power looms stood side by side, weaving cloth that was cheaper, yet finer than anything a king could buy just a few years earlier.

And what fueled this revolution? In some cases it was water power, and the tall factories stood beside large water wheels in Lawrence, Mass., and Manchester, N.H.

In other places, such as in Manchester, England, mighty steam engines burned huge amounts of coal. Thousands of people came to work in these mills. The world sure was changing.

Ah, and there was one more ingredient in this revolution. As the men stood tending to their power looms, they enjoyed a cup of tea. They did not earn a lot of pay, but they could afford

this new treat—a steaming cup of tea with milk and sugar. Just as the mill required intricate iron castings, and ingenious machinery to process the fabric—and water power or steam power—and lots of workers—the last piece that completed the puzzle was cheap caffeine and sugar. It makes sense to me. I noticed some old photographs in museums of workers in the mills in Lawrence, Mass. They were all drinking mugs of tea.

If I worked at a mill, how could I stand around and do my 12 hours of labor, splicing threads and clearing jams on the loom, without good sustenance? Well, tea and sugar ain't good food, but it does provide some cheap energy. Cheap tea from India and China. Cheap sugar from the West Indies.

Myself, I rarely drink tea, except at Chinese or Thai restaurants. I'm a coffee drinker. In January of 1959, I was coming back from a skiing trip, and we stopped for supper at Colby's Restaurant in Rochester, N.H. I had enough money for a simple meal, plus a meager tip, and I had ten cents left over. A glass of milk was 15 cents, but a cup of coffee was only a dime. And with the coffee you got cream and sugar. So I ordered my first cup of coffee, and I liked it. I won't say I'm hooked on coffee, but it sure is a habit. Not unpleasant, not unhealthy, so long as I don't overdo it.

As I sit here typing in my dining room at 5 a.m., I made myself a good cup of Yuban with milk and 1/3 envelope of Equal. It does perk me up. It fuels me, sort of. It makes me feel cheerful. On special occasions, I put in a tablespoon of apricot-flavored brandy, and that cheers me up, too. (Some people suspect that I put a spoonful of coffee in my brandy...)

Does our workday revolve around

the coffeepot? Partly. To a degree, a cup of coffee provides energy and enthusiasm, and the focus around the coffeepot does provide social interaction, too. Somebody was proposing that we should rearrange our departments at National. I proposed a plan of concentric circles with Design Engineers and Marketing and Product Engineers and Test Engineers all arrayed around a central, pivotal, ESSENTIAL zone of "Coffee Bob's" coffeepot. I don't think Gil Amelio is gonna take my advice—the "concentric circles" might get awfully awkward—but I wish he would.

What does coffee go with? It goes with planning meetings. It goes with friends. It goes with driving. It goes with many kinds of food.

It goes with cookies. It goes well, I find, with spicy foods such as chili con carne and Mexican food. It goes well with cake. And with donuts. And I used to hate biscotti, those long, hard, dry cookies, because they were so hard and dry. I have *no idea* why no one ever explained this to me, but while biscotti by themselves are *terrible*, biscotti with coffee are *excellent*.

I may also mention that sometimes beer goes well with Chinese food, but sometimes tea is just right. Sometimes Thai iced tea is excellent to drink with a meal; however, if you go to Thailand, and order Thai iced tea, don't expect to get the smooth vanilla-scented iced tea you get at Thai restaurants here in the States.

Some people insist on cream and sugar—also known as "coffee Boston," which is half milk. Others will only drink it black. I recall an old friend Ed, who complained bitterly when his sister took her half cup of cold, heavily-sugared coffee, and poured it back into the coffeepot to warm it up, thus ruining it for people who like coffee without sugar.

Some people love iced coffee; others can't get interested. Some people demand their coffee fresh-brewed. Myself, I don't mind a cup of good coffee when it is reheated. Consider the old German phrase—"Kalt kaffee macht schön"—cold coffee makes you beautiful. Maybe it does? You figure it out.

Of course, there is sometimes a "dark side" to all this coffee habit. Caf-

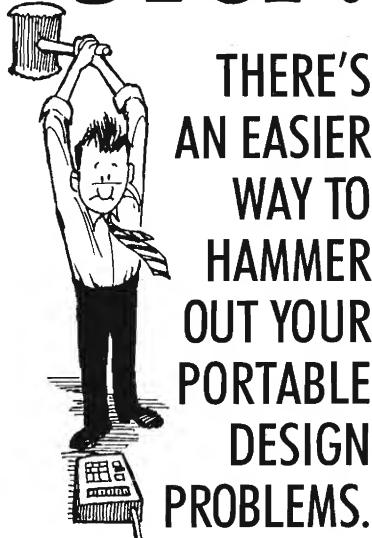


BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCTOR CORP.,
SANTA CLARA,
CALIF.

in these mills. The world sure was changing.

Ah, and there was one more ingredient in this revolution. As the men stood tending to their power looms, they enjoyed a cup of tea. They did not earn a lot of pay, but they could afford

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PEASE PORRIDGE

feine is definitely an addictive drug, which can cause significant changes in both mood and physical performance. When the Product Planning meeting gets over-hyped and starts proposing crazy ideas like "let's introduce ICs in designer colors like Swatch Watches..." you begin to get suspicious. When you find people pouring coffee from a pot, that hasn't been cleaned in months, into a matching cup, you begin to get suspicious about the disinfectant qualities of coffee. Is it really the strength of the java that insures that nobody gets sick or dies after drinking that swill?? OR maybe they just added the vinegar *in with* the coffee, instead of perking the vinegar on a separate cycle??

Conversely, when someone cannot get his "fix," that is not a pretty sight to see. When a guy gets too "wired," that is sad, too. And when the work output starts falling off at 9 dB per hour after 3 p.m., there is sometimes a reason.

One engineer pointed out that when workers went through some double-blind tests, with decaf coffee and caffeine pills or placebo pills, the ones that got caffeine pills felt they were working faster—they were more alert, scored better on tests, and had a more positive mood. When performing a given amount of work, they had a lower heart rate, which may be attributed to dilation of the blood vessels by the caffeine.

Those who got no caffeine, only a placebo, had more headaches, and felt flat, listless, and drowsy. But if you ever have to go through caffeine withdrawal, you'd wonder, is it worth it? YOU figure it out.

After all, recent studies indicated that drinking more than 5 cups a day can be bad for the health of some (but not all) people. Even one cup a day is bad for some people with heart problems. It is claimed that drinking coffee that drips through a filter may be slightly less unhealthy, as the filter removes some of the oils found in perked or espresso coffee, oils that correlate with some kinds of heart disease. But some of those oils bring out the best, most intense flavors to your coffee experience. And when a woman is trying to get pregnant, drinking more than 3 cups per day tends to decrease the chances of getting preg-

nant, according to a recent study. This does NOT mean that drinking 16 cups acts as a kind of birth control—at least not directly. YOU figure it out.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:
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National Semiconductor
P.O. Box 58090
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BOB'S MAILBOX

Dear Mr. Pease:

I enjoyed your article in the Nov. 20, 1995 *Electronic Design Special Analog Issue*. I was reminded of a servo system which amazes me every time I see one. I don't know the official name of the device, but it's a free standing square tower with a beam across the top. The beam has a counter weight at one end, and a carriage which can travel back and forth along the beam. From the carriage hangs a long cable into which various heavy things can be attached. A small shelter at the top of the tower houses the operator, who can rotate the beam around the tower, control the tower position, and raise and lower the cable.

A typical use for the device is to pick up a huge bucket of cement from one area in the construction site and set it down in another area. Even though this usually requires simultaneous radial and angular motion (sometimes with the load being raised and lowered at the same time), I've never observed the slightest pendulum effect, even with the action proceeding at maximum speed on a windy day. I have to believe the system stability depends entirely on the skill of the operator. I see no reasonable way to sense the location of the load, considering the environment. Any comments?

ROBERT J. DEHONEY

Isle of Palms, S.C.

There are all kinds of Derricks and Cranes. The operators have excellent skills at preventing oscillations, and damping them out if they occur. Sensing the load's location is done by Eye-ball. Servo is seat-of-pants and experience.—RAP

PEASE PORRIDGE



BOB'S MAILBOX

Dear Bob:

Recently, several letters to you were published discussing reliability, old tube systems, and PID control. I would like to add the following story that I enjoy telling young engineers and Ph.Ds.

Back in 1956, while completing my masters degree at the Leningrad Telecommunication Institute, I was sent away for a month to get an experience in servicing long-haul telecommunications systems connecting Leningrad to Moscow. At that time, there were a great variety of systems in operation. Together with a relatively modern German coaxial system, many open-wire 12-channel systems were still operational, most of them of a Russian design called the V-12. But two of the systems were of the American type called the J-2. The KGB employed these J-2 systems for their better reliability. I learned that both V-12 and J-2 used the same tubes (Russian clones of American designs). However, the V-12 tubes needed to be changed once every four months, while the same tubes worked for years in the J-2. I was very confused. What could make the tubes last longer in American systems? Why were they so much more reliable than the Russian ones?

My friend and I looked into the V-12 repeater design. The inside was typical of a tube receiver of those days: Tube sockets, resistors, transformers, and some chokes. Okay, this is normal. Now, what exactly is inside the J-2 repeater? We opened one up. Inside, there was no free space. Small sealed boxes with inductors and capacitors filled the case. Why did they need so many of them?

Later, I was lucky enough to be sent to work at the R&D center of the largest Russian telecommunications plant, where I learned the answer. In Russian systems, the feedback compensators were of relatively low order, 5 to 8. Although much better than PID compensators (which are 3rd order), they were not a match for the 15th-order (and higher) compensators in the J-2. With these compensators, the theoretically optimal transcendental responses de-

fined by H.W. Bode were closely approximated, and the feedback was about 10-dB larger than in the Russian repeaters. To compensate for lower feedback, the anode voltage was increased in the Russian repeaters from 120 V to 140 V, in order to achieve the same degree of linearity and nonlinear crosstalk. But the price paid was overheating the tube. The lessons I learned were the following: The simpler system is not necessarily more reliable, and it pays to maximize the feedback.

In the work on transistor telecommunication systems that followed, we used Bode methods to the full extent, for single-loop and multi-loop systems. Later, in the U.S., I used Bode methods (not to be confused with Bode diagrams) to improve CATV amplifiers with 0.6 GHz-bandwidth, spacecraft thermal controllers with 10-MHz bandwidth, controllers for a 100-KV, 1.6-MW power source, and controllers in the mW and μ W power range for electrically- and mechanically-flexible systems.

When asked where these methods can be read about, I keep telling my colleagues and students that the best place is Bode's book of 1945, *Network Analysis and Feedback Amplifier Design*, published by Van Nostrand, N.Y. The book is now hard to find (although many editions were published in the 40's and 50's). Still, even when found, the book is usually not read. It is not a textbook, is hard to read, and it gives the reader a good excuse to stop wasting time on it. Besides, tubes are pictured in the illustrations, and everybody knows that tubes are obsolete.

BORIS J. LURIE
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, Calif.

Boris, you're correct that sophisticated design sometimes does lessen the demands on hardware. But in Russia, labor costs for frequent retubing were low, so that was an economical choice. As for Bode's book being hard to appreciate—hey, you're a good explainer—you should rewrite the book to in-

crease comprehensibility.—RAP

Dear Bob:

Through reading your column in *Electronic Design*, I have come to the conclusion that you are a rather irascible character and therefore somewhat likely to be sympathetic with one of my "pet peeves" in life. It concerns the sizes of paper, including photographic paper, but mostly the 8.5 in. by 11 in., or A size, and multiples from that size.

It seems fairly obvious to me that all paper sizes should have the longer dimension related to the shorter dimension by the square root of two. Then, any document, such as a schematic, could be reduced or enlarged properly to fit the adjacent size. In my case, I have been frustrated by my inability to reduce a C-size schematic to fit correctly on a B-size sheet of paper. If the A size were to be "corrected" to 8.5 in. by 12 in., and the B, etc., to multiples of that, my life would be much happier—not that I expect it to happen in my lifetime. Thanks for the opportunity to get it off my chest. I enjoy your column, especially when it touches on the "good old days."

PHIL FOLWELL
Technectics Inc.
El Cajon, Calif.

Phil, I'm an analog man, so I never get annoyed by the way that A-size paper does not have a w/l ratio = $\sqrt{2}$. I won't even complain that it does not conform to the Golden Mean = 1.618 = $0.5 + \sqrt{1.25}$, or any other reasonable number. But if you want a nice match between one B-size and two A-size prints, go to England and try their A4 paper. It is NOT metric, but 8.25 in. by 11.69 in., which should make you deliriously happy. Myself I'm not a big fan of A4 paper.—RAP

Dear Mr. Pease:

I work with a small company in Pennsylvania that develops handheld voice recorders that use digital, solid-state memory devices. I often find myself working with the surface-mount

PEASE PORRIDGE

prototypes trying to put on the finishing touches and tweaking the pc boards. And my question is, why are the surface-mount resistors labeled with their value, and not the surface-mount chip capacitors? Is there some problem with the labeling changing the capacitance of the chip capacitors? It can get really aggravating when you get a pile of surface-mount parts and you need a certain value—and all the capacitors, although they are not all the same, sure look the same. With this, I have come to realize how important it is to sort each part and document every component change step by step. Don't wait until you are done to make any notes!

ROB SILBERT, Engineer

Sycom Technologies

Bala Cynwyd, Penn.

Rob, capacitors have almost ALWAYS been labelled badly. Ever fool with old micas whose color codes you could not decipher, even after you measured them with a C-meter? Yes, taking good notes as you go along is one trait of a good engineer.—RAP

Dear Mr. Pease:

Last night the late show featured the old science fiction classic *The Forbidden Planet*, with Leslie Nielsen, Anne Francis, and Walter Pidgeon. One of the characters in the movie is Robby the Robot. At one point the robot says, "Something is approaching from the Southwest. It is quite close." Since the movie was made in 1956, would this be the earliest recorded instance of artificial intelligence using Fuzzy Logic?

WALTER E. GATELY

Bedford, Mass.

It's not well known, but the tiny man inside "Robby the Robot" was really Lotfi Zadeh. The cheap plastic eyeballs they gave him to peer out of made everything look fuzzy—thus launching Dr. Zadeh's meteoric career.—RAP

All for now. / Comments invited!
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WHAT'S ALL THIS R-C FILTER STUFF, ANYHOW?

Once upon a time, one of my colleagues applied for a patent. It was a nice, simple little invention. The basic claim was a circuit comprised of just two resistors and two capacitors. That's *all*. Now, if you have ever studied what patents are like, you will ask, how could there *possibly* be a patentable invention made up of only two Rs and two Cs? No matter *how* you connect them? How could such a patent be granted?

Well, I guess I have to admit, this patent was not filed last year; it was filed May 18, 1951, and issued January

10, 1956. So you were correct to be doubtful about how such an invention could be patented *these days*? And the appropriate comment is, gee, 40 years does not seem like such a long time...but that was a long time

ago. If you could go back 40 years in a time machine, you would be a very smart person. Since 1956, about 2,800,000 U.S. patents have been issued—the number has more than doubled. Ignoring

mere historical happenings, if you could fill up your mind with inventions, and go back 40 years, you would be smarter than a million inventors were in 1956.

In addition to the basic claim that covered two resistors and two capaci-

tors, it had another claim that specified an expanded version of the invention, with three resistors and three capacitors. Okay, if you could get the first claim approved, then you probably could, in 1956, get that second claim approved.

The neat thing about this second circuit is that you can use it to make a phase-shift oscillator. In fact, if you have a unity-gain-follower, such as an op amp with gain of +1.00, or maybe even a single transistor connected as an emitter follower (collector riveted to ground), you can make an oscillator. Not just a MegaHertz oscillator, but a 1-Hz oscillator. Or, a 1-cps (cycles-per-second) oscillator, as we said back in those days. (I hate to be grouchy, but I still like to say *cps*, at times, even if it does take three times as much work as *Hertz*. Sometimes I like to say *cycles per second*, and that takes five times as many syllables. Yet, for everyday usage, saying *Hertz* is very frugal and efficient.)

Hey, wait a minute, Pease, you just said that one could connect this patented circuit, made of three Rs and three Cs, and a unity-gain voltage follower—and make a slow oscillator? Yes, I did say that. But a circuit can only oscillate if the gain around the loop is greater than 1. That's one way to state the Nyquist criterion, that for oscillation to occur, you have to have at

least a little more than a gain of 1 around the loop. Yes, that's right.

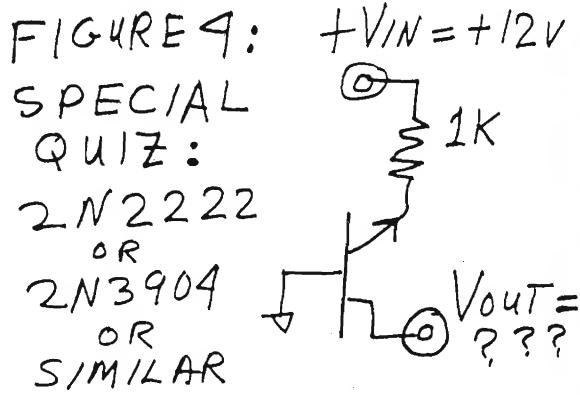
But, Pease, if the amplifier does not have a gain greater than 1, then the R-C network would have to have a gain greater than one. Yes, it would! But, Pease, that is absurd! Resistors are passive. How can you take a network of Rs and Cs and generate a gain greater than one?? That's impossible!! No, I don't agree. It is NOT impossible. YOU or I can take 3 resistors, 3 capacitors, and a unity-gain follower, and make a 1-Hz oscillator.

For example: Let's take three tiny little 0.01- μ F capacitors, and three 22-M Ω resistors, and an LMC7101 op amp (0.11-in. square) which could easily be assembled on a small PC board, 0.3 in. x 0.6 in., or 0.2 in. x 0.4 in., or smaller.

Really? This is some kind of April Fools Joke, isn't it? No, it's not. It is obscure and quirky and weird. But it is absolutely true. Okay, we give up. How did you do this "oscillator?" How do you make an R-C network with a gain greater than 1?

Well, first, I must admit that the inventor was an old supervisor of mine, none other than George A. Philbrick. He founded Philbrick Researches (which just went out of business a few years ago), and was one of the pioneers of Analog Computing, and one of the fathers of the Operational Amplifier. So if I told you that, you'd be a little less inclined to doubt my statements.

Next, I can tell you that the patent is number 2,730,679. You could order this from the patent office, if you want



PEASE PORRIDGE

to see what a good old patent looks like.

I can then tell you that the title of the patent is a "Delayed-Recovery Electric Filter Network." In other words, George thought of this as an improved circuit for ac coupling for a signal presented to a scope. Figure 1 shows how the basic claim is made, with two Rs and two Cs. If you have a 5-V dc level at the input, plus a small ac signal, the ac signal is presented to the scope, and the dc is blocked. This is not exactly the same as the well-known, conventional C-R, C-R filter, as in Figure 2. That one rolls off at 12 dB per octave. But Figure 1, despite its complexity, just rolls off at 6 dB per octave. It really is a *different* circuit. Which explains why George got his patent.

Now refer to Figure 3. It's a simple extension of the concept of the circuit of Figure 1. What if we put a +1-V step into the input? Momentarily, the output will rise +1 V. But, after a while, the output will go back down toward

ground. But it never goes below ground. However, if you go back and put a step into the circuit of Figure 2, the output *can* go below ground—in the time domain.

So, if one R-C circuit has an overshoot in the time domain, maybe it is not too silly to concede that a different R-C circuit might have a gain greater than 1.000, in the frequency domain? And that is what happens. If you actually build this circuit, at $f = 1$ Hz the gain will be about 1.03. Of course, you will need a high-impedance buffer, such as an op-amp follower, to let you see this output without loading the network. If you change the resistors' values from $22\text{ M}\Omega$ to $22\text{ k}\Omega$, you will be able to see this at a much more reasonable frequency and impedance level. Then when you go back to $22\text{ M}\Omega$, it will work just as well, but slower—with a gain greater than +1.000.

If you actually connect the input to the op amp's output, with link L1 as shown—it will definitely oscillate, with an approximate sine waveform.

So if somebody wants to make you a bet on some circuit that is "impossible," you should be very cautious about making a rash response.

For example, in the circuit of Figure 4, if you take any NPN silicon transistor such as 2N3904, 2N930, or 2N2222, and apply +12-V dc through the $1\text{ k}\Omega$ resistor to the emitter—what voltage will the collector go to? One might argue that, if this is a grounded-base amplifier, the collector might go off to some bizarre voltage—such as +0.5 V, or -0.5 V. But how could the collector go to -0.5 V? There is no negative voltage in the whole circuit. How could the collector do that? Absurd. So, the output would have to go +. Right?

So, YOU figure out where the collector voltage will go to. Don't spend more than an hour thinking about it.

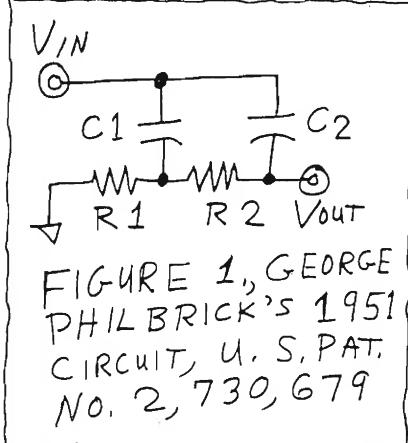


FIGURE 1, GEORGE
PHILBRICK'S 1951
CIRCUIT, U. S. PAT.
NO. 2,730,679

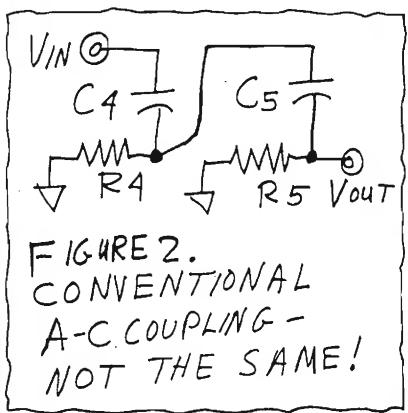
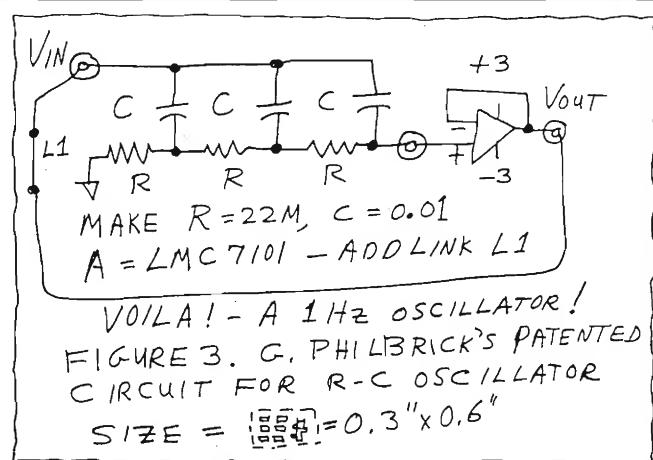


FIGURE 2.
CONVENTIONAL
A-C COUPLING—
NOT THE SAME!



Then, after you measure the voltage, don't spend more than 2 weeks puzzling about the answer, or wondering how it got there.

Just don't get mad at me if you measure the voltage and then do not like the answer. When this question was first put to the guys at Analog Devices, I was told they were furious for hours and days, before and after they found the answer.

In fact, they were so furious that they dumped the question on Jim Williams and the guys at LTC. And they were mad as hell, too. And they dumped it on me. And I laughed like heck. I figured it out, fast. And now I'm dumping it on you.

The solution will be provided in two weeks. It would not be fair to ask you to wait longer than that. This is a mean, nasty question, but it is NOT a hoax. There IS an answer, and the answer is valid. It is, admittedly, a fooler.

Just one suggestion: Don't bother asking Spice to give you an answer, because it will not give you any valid answer—not that it usually ever does. But any circuit that gives an answer that Spice is incapable of finding, could be a fooler. Hey—every circuit is a fooler!

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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National Semiconductor
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PEASE PORRIDGE



BOB'S MAILBOX

Before we launch into this month's letters, let's start out with the answer to the brain teaser posed in Bob's April Fools column, which—because Bob is Bob—appeared, naturally, in the March 18 issue.—Ed.

THE SOLUTION:

The output—the collector—goes to about -0.4 V, assuming you use a high-impedance voltmeter ($R_{in} >> 10 \text{ M}\Omega$), even though there is no other negative voltage in the circuit. It does this whether the transistor is packaged in a metal can, plastic, or epoxy.

WHY? When you break down or “zener” the emitter, it emits light. Red light. You can see this if you look through a microscope. This light shines through the silicon lattice and causes enough photocurrent in the c-b junction to force the collector negative. The actual current that goes to the collector is about $1/10,000$ of the (reversed) emitter current. If you have a VERY sensitive curve-tracer, you can see this transfer gain, which is fairly linear.

This is NOT an April-Fools Joke. It is not even a HOAX. It is merely an example of a little-known and unappreciated mechanism—the base-emitter zener emits light, and the collector responds to this light which was generated nearby. What, an LED made in silicon? Yeah, and we do this a million times a day. When we use a “zener zap” to trim our circuits, and blast 600 mA into a tiny zener, it gives off red light every time. What's a zener zap? Oh, didn't you know that? Maybe I should explain—later....

P.S. After you have zenered the heck out of that V_{eb} , don't throw the transistor back in the drawer, as you may have damaged it or warped its characteristics.... Best to throw it out. Or Widlarize it.—RAP

Dear Mr. Pease:

While reading your “What's All This Mental Exercise Stuff, Anyhow?” in the Dec. 4, 1995 issue, it occurred to me that you might have

missed a couple of important lessons to be learned from the two pairs of violins discussed in the Mead reprint.

Creative Environment: First, the two violins that sounded better were let out of their “controlled” environments and allowed to function freely. This is also true for humans. Cubicles, standardized schedules, and cookie-cutter mindsets need to make way for a more-flexible work environment (i.e. flex-time and home offices). Note: With the obvious exception of wine, which in reality is a special group effort, anything left in a sterile atmosphere degrades over time.

Exercise: Secondly, the two better-sounding violins were placed on a daily exercise program. For years, doctors have condemned inactivity and advised us that we need at least 20 minutes of exercise, three times per week. It occurs to me that these two violins were just reaping the rewards of a good exercise program.

Moral: Violins, like people, need to lead an active lifestyle in a friendly environment in order to reach their full potential!

DAVID W. BRUDER
Senior Mechanical Engineer
Sparton Corp.
Jackson, MI

David, I love analogies, but I am not sure if the “practice” that is good for a human is in every way analogous to “exercise” for a violin. Do you remember the canary whose cage sat by the radio? He never learned to sing or whistle; he just learned static.—RAP

Hi Bob:

The insight in your columns, both technical and human, brings interesting new views and information to your readership. I hope you keep it up for a long time to come.

On your comments in the Dec. 4, 1995 issue about the workings of the human mind, how about some thoughts about machine memory—like what is found in computers and more in line with your expertise?

There is a great debate going on about whether to leave computer equipment operating continuously, or turn it off when not in use. I am a proponent of “turn it off” when not in use for a reasonable length of time, like overnight.

My defense is that I have yet to see an electronic part that gets better with use compared to having it sit on the shelf. And if the ON/OFF shock damages the equipment, then the design has a fault that needs fixing. These are fighting words to many people out there in the real world. However, a computer operated for only 10 or so hours daily should theoretically have an MTBF over twice that of a computer operating continuously. The first step in accelerated life testing, before additional heat or voltage, is continuous operation. These are thoughts to ponder. What is your input on this debate, Bob?

JOHN H. ROLLESTON
Mettler-Toledo Inc.
Worthington, Ohio.

In the old days, we left our good vacuum-tube equipment ON all the time, so the heat would keep the carbon resistors dry, yielding best stability—and less warm-up drift in the morning. If the power bill is not a big deal, I still like to leave equipment ON all the time, so long as it's not running hot. I don't think this hurts reliability. If it IS running hot, as some Function Generators do, I like to add a heat fin or fan to keep the hot spot from getting too warm. I do not expect the MTBF of any good equipment to double, if you just turn it OFF when not in use. I just have a hunch that it's better if left ON.—RAP

Dear Bob:

Your Dec. 4, 1995 “Pease Porridge” evokes a personal story re: “Aunt Tillie and her crossword puzzles.” My late wife, Esther, was (before the onset of discernible symptoms of dementia) one of the most cognitively-skilled (perhaps, even gifted) persons I have ever known. She not only had an enviable memory, she had the ability to

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PEASE PORRIDGE

organize, plan, and integrate information in her head without resorting to charts, lists, notes, and memos that I have always needed. She was an avid game player and worker of crossword puzzles and similar "brain-teasers."

What Esther *did not do* was decide one day *not to do* crossword puzzles. (The decline began in her mid-fifties.) Actually, she spent more time on them as her skills declined. But what happened is she gradually lost the essence of what the puzzles were about, but kept trying to fill the squares. When she could no longer translate clues into words that fit, she began to write (or copy) the clues themselves into the puzzles. Then it became random words. Then random letters. Then random marks (actually, I believe they were ones and zeros).

It was the same with everything she had done formerly. She did not quit and then lose the skill. She hung in doggedly trying to continue to do everything she had done previously, up to and even beyond the point of losing the skill to perform the task competently. In most cases, she did a brilliant job of covering up or rationalizing her loss of various skills. She ran on momentum and sheer habit in many activities well beyond the point of losing conscious understanding.

AS far as I can tell, she never voluntarily "retired" from anything. The last phrase she ever articulated came when I was discussing with a nurse her inability to feed herself, and she unexpectedly and clearly interjected "I don't know how."

I don't know that this proves anything. I don't know whether some persons retire and "lose it," or whether they retire *because* they are already losing it and it's becoming too hard to compensate and cover up. Maybe it's a mixture. Either way, I'm going to keep doing and thinking as long and hard as I can. Thanks for an interesting article.

L. D., Colorado.

The human mind struggles to do its best, and when it can't do things right—I guess it just improvises. Sometimes the mind—or the body—degrades in function despite good exercise. I'm sorry about Esther, sounds like she was a fighter.—RAP

Dear Bob:

Re: "What's All This Mental Exercise Stuff, Anyhow?" I was amused by the quote "...how researchers are beginning to understand a lot of how the brain works." If you dig a little bit deeper, you would be aghast at how little they know (and a lot of that little is, in the words of Pauli, "not even wrong"). Brain anatomists have given cute names to all the brain structures ("inferior olive," "substantia nigra," "amygdala," etc.), but if you asked them what the function of a particular structure is, they don't have a clue.

Sure, the brain is self-repairing. That comes with the territory. If you wish to create a self-repairing entity, start by making it self-generating. (I am referring to the *content*, not the *hardware*.) People who have a habit of thinking have richer information structures, and hence have more pathways that can be used to "shunt" around deficiencies.

If the brain suffers a (non-massive) stroke, a relatively small area of tissue may be destroyed, together with its content. The brain can then figure out a "work-around" that alleviates the damage. Although sometimes (depending on the locus of the stroke), a whole knowledge category (specific groups of words) may be destroyed. This damage is like a bullet wound—relatively small and localized. In the case of Alzheimer's, the damage is more akin to being hit by a shotgun blast. Random neurons are destroyed. If one of the "pellets," so to speak, hits a *pathway*, everything at the remote end is lost. So Alzheimer's is more insidious and can be vastly more damaging.

MAX BEN-AARON

Bedford, Mass.

Your ideas are consistent with what I have heard about Alzheimer's. Fortunately, researchers are making pretty good understanding on HOW Alzheimer's disease does its damage, which may help lead to a cure.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

WHAT'S ALL THIS SPRINGTIME FLOOBYDUST, ANYHOW?

Well, It's *flooobydust* time again. So here's another collection of various odds and ends that I've been gathering.

• Several people were quite quizzical: In my column on Ball-on-Beam Balancing in the Nov. 20, 1995 Special Analog Issue, I mentioned that I had written about PID controllers in the June 29, 1994 issue. WRONG DATE! The PID Stuff was in the June 26, 1995 Analog Special Issue. Sorry. If you need a copy, holler.

• Meanwhile, I optimized my Ball-on-Beam Balancer (BOBB) for better settling than I had last November at WESCON. I improved the settling time from about 10 seconds to approximately 4 seconds. That is

MUCH faster and smoother than the Fuzzy Logic Version. And with only a slight percentage of overshoot. Actually, I have tweaked it up to show settling time down near 3.2 seconds—BUT, if any noise ever gets into the system, it starts flipping the ball into the air!

And the ball does not always come down on the beam! In other words, it's getting pretty shaky. But when set up for 4 seconds, it's fine, and very well behaved. In the meantime, I'll be working on further improvements.

I sent a videotape of my good

WESCON BOBB Demonstrator's performance to Dr. Li, but he claims he has not looked at. He says he is not interested in sending me a copy of HIS videotape of HIS Ball-on-Beam Balancer, even though he has sent copies to many other people. What a sore loser!! But maybe he is just ashamed. Co-author Dr. William Marcy, the Dean of the Computer Science Dept. at Texas Tech University, is unresponsive, too.

Dr. Li still claims Fuzzy Logic has advantages when you have a badly nonlinear system—such as a Ball-on-Beam Balancer. He claimed his system was superior because it still worked OK when he stacked some paper clips on his beam. I set a pair of pliers that weighed as much as 300 paper clips on my beam, and it still worked fine. So I'm supposed to be impressed by Fuzzy Logic?

• Back in the March 4, 1993 issue, I wrote about trying to engineer a better scheme to charge the batteries for my camcorder with a hand-crank generator or similar scheme. I recently found some information about a refillable chemical battery that just uses magnesium cathodes in a salt water solution. This version weighs 4.6 lb. complete, dry. Then when you add 8 oz. of salt and 48 oz. of water, it can put out as much as 0.4 A at 10 V. You can get about 80 Ah on one charge, which costs barely \$12 for the anodes. This is about two times better than 6 sets of 8 alkaline D cells (which provide about the same power), both in COST and in WEIGHT. So if you want a reasonable number of watts, and you don't mind 4 extra pounds in your canoe, this is a good solution for about \$139. Call Ashford Associates in Boca Ra-

ton, Fla., at (407) 368-5966, and leave your address. The "battery" is able to put out full power in about 30 seconds after you pour in the salt water.

But if you stop drawing power, it is recommended to remove the salt water from the electrodes, within a couple hours. Don't leave the salt water in there indefinitely, and don't throw it away—just save it until you need power again. When you have used up the electrodes, and you have to add 1 lb. of new magnesium electrodes, and also 1/2 lb. of new salt in new water, the residue (salty, magnesium, water) is non-toxic.

• I thought about buying one of those batteries, but decided it was too heavy, and I don't need that much juice. Instead, I invested \$90 in a 17-V, 0.25-A solar array, Solarex Model S-MSX5 from Backwoods Solar Electric, Sandpoint, Idaho. Call (208) 263-4290 for a catalog. This weighs about 1.2 lb. and I can tie it on top of my pack. I should be able to charge my batteries full, easily, and I can thus survive a day or two of clouds. We shall see. It's no heavier than my old hand-crank, and I couldn't record much more than 20 minutes a day of video, with that.

• Back in the October 25, 1994 issue, I griped that I often got a 150-yard offset between my known position and my GPS receiver's computed position. When this happened consistently in my OWN FRONT YARD, I got suspicious. After several fruitless inquiries, a sailor tipped me off: "Bob, are you using the wrong DATUM?" I checked. I was using the wrong datum. When I switched to the North American Datum 1927 (NAD27, commonly specified on most USGS maps), the error cut in half. Ahem.... (What's the old saying about the "sudden cessation of stupidity??")

• I've waited over a year, and still no one has told me of anybody selling an ordinary 1/4-in. electric drill. (I don't count battery-powered drills or professional models costing \$120.) Sounds like a conspiracy to me....

• If you really want a sweatshirt that reads, "TEAM EFFORT is a lot of people doing what I say"—call The Paragon at (800) 343-3095. Or, from



BOB PEASE

OBTAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

And the ball does not always come down on the beam! In other words, it's getting pretty shaky. But when set up for 4 seconds, it's fine, and very well behaved. In the meantime, I'll be working on further improvements.

I sent a videotape of my good



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PEASE PORRIDGE

overseas, call (401) 596-3000. The cost is about \$33. Sorry, t-shirts are not available with this pattern.

• Just in case anybody out there prefers old cars to new cars, be aware of efforts by bureaucrats, politicians, industrialists, and environmentalists to get us to trade in our "old" cars. Despite the denials, we are very suspicious of the wording and interpretation of new laws that will force "old, polluting cars" off the road, and to eventually confiscate them. This is not the same as voluntary trading-in of old polluting cars, and it is not related to the use of old cars that do not pollute. FURTHERMORE, an "old car" may be as new as 4 years of age. I don't know ANYBODY who wants the value of their new car to go to zero, in 4 years, because of some stupid bureaucracy, unless it's the guy trying to sell you another new car.... We'll keep an eye on this—especially the laws in New Jersey, where various test cases may be moving ahead.

• A couple of people pointed out that while typing is notorious for causing wrist strain and carpal tunnel syndrome, using a "mouse" can be just as bad. Personally, I hate all this double-clicking junk. My fingers do not like it. There are, however, other pointing and positioning schemes that are better than a mouse, and if you inquire, you may find one that gets along with you. Recently one reader observed that a wrist-cushion is a bad idea for carpal stress. But several people told me he's wrong. So, you find out what is best for *you*. Get your doctor's advice.

• As you read this, I'll have just returned from a month in Nepal hiking with Peter Owens Treks near Dhorpatan and Dhaulagiri—but only up to 11,000 feet. If you want a good hike, an easy or moderate trek, call (510) 222-5307 or (800) 223-1813 and ask for a brochure. Would we keep going back to hike with Peter if we didn't think his trips are grand, yet reasonably priced?

• A quick comment on a new book—*What Engineers Know and How They Know It*, by Walter G. Vincenti, Johns Hopkins University Press. It's about

\$15, paperback; ISBN 0-8018-4588-2. I definitely recommend it to any engineer who has ever been interested in airplanes. Unfortunately, it is mostly about the history of airplanes and aeronautical engineering, not electrical engineering or electronics, or else I would recommend it to ALL of you guys. Did you ever wonder how the B-24 drew its superior performance from the Davis Wing, and why the Davis airfoil was never used after that? This book treats the multiple levels of awareness of knowledge and technology—the *epistemology* of engineering. Fun to read. Lots of interesting little stories.

• One more item: If you are getting jaded about all the hoopla and hype for "Continuous Quality Improvement," and you're skeptical of the spiralling Quality Bureaucracy, send a line to Q.C. Anonymous at ALCOR Entertainment, 5501 Pleasant Avenue S., Minneapolis, MN. 55419. They have a nice little newsletter they can send you about the foibles of TMQ (Totally Misguided Quality).

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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BOB'S MAILBOX

Dear Bob:

Excellent column on ball-on-beam balancing. Replacing a 50 MHz/486 with a quad op amp...hmmm. Now, if you can just find a common-sense replacement for hogs-at-the-trough Microsoft Windows. Let's put Bill Gates out of a job. It brightens my day to see a couple of geek Ph.D's assaulted with reality and sober thinking. And, by the way, nice self portrait!

HANK WALLACE

President

Atlantic Quality Design Inc.
Fincastle, Va.

Gee, Hank, let's wait until the Fuzzy Logic guys have a replacement for Windows 95, and then I can replace THAT with a couple quad opamps.—RAP

PEASE PORRIDGE



BOB'S MAILBOX

Dear Bob:

Your column in the Jan. 22 issue, "What's All This Picofarad Stuff, Anyhow?" was most interesting, particularly the paragraph about the "old Boonton Bridge with dials, model 75A-S8" and the accompanying photo.

My dad was the engineer who designed that bridge! It was first marketed around 1960 by the Boonton Electronics Corp., then located in Morris Plains, N.J. At that time, he was vice-president and chief engineer at BEC, having been one of the company's founders when it began marketing electronic test equipment in the mid-1950s. He is still well and active today at the age of 89, though he has long since retired from the daily grind of design/development engineering. BEC is still in business too, but the 75A is no longer in their catalog.

If any of your readers have questions about bridge circuits or making accurate measurements of small capacitances at high frequencies, there is probably no one more knowledgeable on the subject than my dad. I am sure a couple of letters would brighten his day and give him something really interesting and challenging to think about for a change. Please write to:

John H. Mennie

P.O. Box 51

South Chatham, MA 02659

DON MENNIE

Technical Editor

Illuminating Engineering Society of North America

New York, N.Y.

Ever since I started at Philbrick in 1961, I've never been more than 80 feet from a good Boonton Bridge. I wrote to your father, and I hope some of our readers will write, too.—RAP

Dear Bob:

Interesting "puff stuff" in your Jan. 22 column. Here's my story: A few years ago, a colleague and I sweated bullets over a design that we were three months behind on. We had to get rid of crosstalk between a bank of

tightly-packed DIP relays that were switching 1 mV of audio. The bean counter in me said that we could afford only one AGC/preamp. So we separated each relay on the pc board with a steel shield. But the crosstalk was still only 55 dB down, and we were looking for 60.

After much gnashing of teeth, we finally cut a narrow slot in the pc board about an inch long between each relay, and put an extension of the shield right through the board, a bit longer than the through-hole leads of the relays. The leads stopped talking to each other and we got 6 dB out of it. Still dimly shouting over the walls, we gave ourselves an insurance policy by putting a flat steel roof on top of the walls, worth another couple of dB. When we were all done, we estimated that we killed about 1 pF. The lesson: Learn to respect the puff.

We went into production with our fingers crossed that nothing mechanical would change. Nothing ever did, at least not enough for the testers to sniff.

MIKE PERKINS

Rauland-Borg Corp.

Skokie, Ill.

I agree, planning good shielding and guarding, as early as possible, is a form of wisdom. But do you think putting ground foils and shields on the pc board wouldn't have been almost as good as cutting slots, for eliminating crosstalk?—RAP

Dear Bob:

I enjoyed your column on picofarad capacitors. I recall a test given at MIT in which we students successfully used a variety of formulas we had learned to analyze the behavior of a given circuit schematic. The test then asked the question, "In a real-life implementation of this circuit, what would be a typical value for capacitor C1?" The answers to that one were all over the place, some ranging as high as thousands of Farads. Apart from the electronics experimenters among us, the students' knowledge of the

subject matter was entirely theoretical, and many had no clue as to what reasonable real-world values might be.

However, I'm really writing because I'm mystified by your reference to the capacitance of 600 strands, 2 inches long, of silk thread. What did you mean by that? Capacitance between where and where? You noted that silk thread is an excellent insulator. To have capacitance, something has to store charge; how can an insulator do that? Figure 3, which seems to show a transistor hanging from some strands of silk thread, didn't make it any clearer. Just what capacitance are you really talking about? I'm really curious.

LAWRENCE J. KRAKAUER

Kronos Inc.

Waltham, Mass.

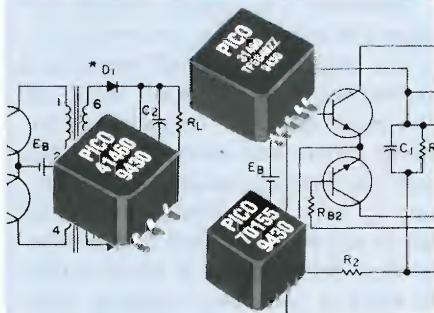
Alas, it's hard for students to learn about the real world. As for the silk threads, that's just a way of saying that the mass of the silk adds a little capacitance. So when you wrap 620 strands of silk thread around a couple metal objects 2 inches apart, that is about 1 pF more than if you only had 20 strands. Of course, 600 strands would support a heavy object—a small oscilloscope, for example.—RAP

Dear Mr. Pease:

Your article, "What's All This Picofarad Stuff, Anyhow?" is excellent, and a worthwhile design reference as well. I seem to recall that back in the late 1950s, when printed circuits were making their debut, we were told that this would assure product consistency. It would eliminate the variations in capacity between conductors, as well as fix conductor inductances and resistances that were not possible with hand-wiring. (Although, for a long time, Zenith preferred to advertise their "hand-crafted" television manufacturing.) Just how consistent has it been? I think it would be a worthwhile exercise for you to tell us how good it has been—that is, if you have not already done so.

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PEASE PORRIDGE

Roy L. Ruth
Senior Engineer
Dotronix Inc.
Eau Claire, Wisc.

Modern etched circuit boards (which we usually call "PC Boards") really do improve uniformity of performance, and reliability, too. I mean, old hand-wired Tek scopes were not terrible, but nobody would want to do without the advantages of modern wave-soldered circuit boards. Not even me.—RAP

Dear Bob

I just finished reading your article in the Jan. 22 issue about measuring capacitance. I thought I would send you a copy of a page from the *ARRL Handbook* on capacitors and the formula for calculating capacitance. It seems you had a terrible time trying to find a simple formula for this calculation. May I suggest you consider purchasing a copy of the latest edition of the handbook. It is a great reference to have around since most of the material is down-to-earth type stuff and easy reading. There are several Ham Radio Equipment stores in your neck of the woods where you can purchase one. Or, you can purchase one direct from the ARRL (American Radio Relay League). By the way, I find your articles fun to read and always learn a little more from them. I also have a copy of your book *Troubleshooting Analog Circuits* and find it to be a good reference.

Bruce W.
Cascade Technology
Sultan, Wash.

I like the *ARRL Handbook*, too, but most of my friends who own one, keep the book at home. And while it has many good formulae, I still haven't found a formula for the C from one sphere (diam = 2000 miles) spaced 230,000 miles away from a sphere (diam = 8000 miles). I'd love to check my estimate of 120 μF .—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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WHAT'S ALL THIS SPEAKER CABLE STUFF, ANYHOW?

Back in July of 1995, Ken Lundgren of Bloomingdale, Ill. had some comments about some manufacturers' claims for their speaker cables.¹ "There is a special digital cable which imparts an 'analog-like warmth' to digital signals." He made several other skeptical and disparaging comments about cables that cost hundreds and thousands of dollars—and I agreed with him that most of these claims are absurd.

A few weeks later, I got a letter from a person who appeared to be a strong supporter of high-end audio, George Kaye. After I wrote him, I received the following cover letter and a revised version of his original letter.



BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

hi-fi. So if you can doctor up \$10 worth of lamp cord with a little C and L so that it sounds indistinguishable from a run of any high-end wire, let me know and believe me, we'll make much \$\$, and I'll buy you your next VW clutch. Unfortunately, many of the people who sell the cable

that you scoff at have tried exactly that, and have failed.

We are retailers and hi-fi is by nature, a fashion and fad business. If it wasn't so, you'd still see amplifiers with wooden cases. But as in any business, some things withstand the test of time, like tuxedos, and some things don't, like leisure suits. So time will tell. But, I tell you there is one hell of a wire business out there. We can't all be deaf!

On the other hand, I have heard many types of speaker cables and they all sound different. I swear! Now you have to consider my background of having the trained ear of a working New York jazz bassist, and I've been building amplifiers since I was 10 years old. I've made a lot of mistakes and have learned from them. So I have 30 years of ear and amplifier training. Also, some people just hear it naturally without much ear training.

I'll tell you I may be fooled one day and be absolutely right on another. The cognitive ear skills are not always at the fore when it comes to listening, so I make any critical judgments over time, days or weeks.

I just sent you a rewrite of my first letter. I hope you don't take offense at my claiming that you are not an expert in this field, but hell, it makes for good reading.

GEORGE KAYE"

Dear Bob:

I enjoy reading your column, but I must stand up for the audio high-end which has come under scathing attack by you and several of your readers. We design, modify, and manufacture vacuum tube audio gear. We've built everything from the complete tube re-

cording chain (Chesky Records, New York City), microphone to A-D converter (just to the input, even we don't like a room full of tubes), to 800-watt triode OTL (output transformerless) tube amplifiers. We enjoy a very good reputation for our ability to get the most from the equipment. I must also add that I am a recording engineer and a professional musician with 25 years of performance experience.

It's easy to poke fun at the high end as Kenneth Lundgren does in the July 24, 1995 issue of ED, because what is discernible only by ear may not be measurable with knobs and dials. The art of audio reproduction can only, in the final analysis, be evaluated by ear (which like a musician's ear or a technician's eye, takes time and effort to train). I assert that neither you nor your skeptical following have actually listened, which is what true high-end audio is all about. If you were to do so, in time as your ear learns the subtle differences in things such as soundstaging, instrument placement and timbre, and bass extension and speed, you too would be scratching your head and saying, "Who'd have thunk it?" By the way, there are many well-trained audio engineers who do things "by the book," and fortunately they provide us with many types of equipment that can be improved with modifications.

Usually your debunking of a questionable theory is excellent, as you demonstrated with the Taguchi Method, and is done with a step-by-step methodical approach. However, I am astounded that you attack something outside your field of expertise on such an emotional level, and abandon the scientific method. I have no problem if you can mount an argument that trashes something in audio, but it has to stand up to the final test, which is the listener's acceptance of the experience.

Anyone can get music out of a handful of components. The music from an early Victrola was touted as realistic, undistinguishable from the original. Our experience has proven this claim has been exaggerated over time. Quality is measured in the domain of taste. The listening experience is rela-

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tive in terms of quality, and what is pleasurable or realistic to one, may sound bad or false to another. You may find a particular brand of scotch the finest for years and then, as someone did for me, you are introduced to some 18-year-old single malt, and suddenly your allegiance is torn, or maybe you can't tell the difference.

I can't go into all the technical things, that at first glance, may seem insignificant but are really important, so here are a few items that we in audio ponder and actually research:

What is the mechanism at the molecular level that governs how wire conducts low-level signals, and is it dynamic? What really goes on in O_2 -free copper wire vs. regular wire with higher oxidation? How pure a conductor is copper? Silver has different electrical properties. Audio hookups with silver sound different. Is different better? Sometimes yes, sometimes no, but different is always different.

Did you ever start your car with jumper cables only to see them stiffen up under the magnetic fields of the current flow? Some of the energy intended from the speaker goes into moving the two speaker wires instead of the speaker, or is lost in the wire's dielectric absorption. Current peaks of 50+ amps are not uncommon in low-impedance 1-2 Ω speakers. The dc resistance of speaker wire audibly alters the ability of the amplifier to damp the motion of the speaker cone. The skin effect, starting to take effect around 10 kHz will change the timbre of the treble. Different wires with different resistance, capacitance, dielectric, and microphonic characteristics will sound different.

Another place to look is in the lowly RCA connector, and the often-overlooked solder joint. Oxidation and cold solder joints cause diode-like junctions with threshold voltages. Low-level information such as the reverberation in a hall may live below the threshold of such a connection and may get squashed or greatly attenuated. You end up turning the music up louder because your ear is searching for information and auditory clues that are there in life.

Every capacitor is microphonic. It

is a transducer. The type of capacitor, the tightness of winding, the dielectric and physical deformation properties of the dielectric, resonance, and damping, all make the difference between a violin sounding like a violin, or a fuzztone electric guitar—whether it is played ppp or fff. Run a square wave from an amp into any cap of about 1 μ F and it will sing!² Polarize a cap with, say, 50 V, through a 1-M Ω resistor and hook it up to the input of an amplifier or scope. Tap the cap with a pencil. Thump-thump!

There are two camps of audio devices—tubes and transistors. While solid-state equipment has made big strides in the last decade, I have yet to hear what is considered the best solid-state amp outperform many of the less-than-best tube amplifiers. Why? One of my theories is that tubes act as little echo plates adding a reverberant warmth to the music and the more tubes the better.

There are lots of other theories, such as even/odd harmonic generation, of an FM-type distortion in a silicon device—ask RF expert Dick Sequerra about this one. Suffice it to say this debate goes on. The question is, "Which sounds better?" Only you can make the call for you.

Does an amplifier with 0.0003% THD sound better than an amplifier with 0.25% THD? Is high negative feedback better? Or none at all? Or somewhere in between?

Then there is the "perfect" digital format that was rammed down the public's throat by the record industry that saw huge profits in re-releasing software with minimal production costs. How can you define the shape of a waveform at say 10 kHz with 4 points? The ear hears these subtle phase distortions, my friend, and says, "This ain't quite right!"

But what are we talking about anyway? Are we sending men to the moon? Saving lives? No. Just entertainment, both for the listeners and the designers. The emotions stir upon listening to a work of art. Your hearing is connected to your emotions and your physical being. ENJOYMENT!!! There is a tinker's pleasure in a field or hobby that doesn't require a PhD to get decent results. Besides,

what harm does it do? Why does it make dial twisters mad, anyway?

The truly ineffective fads (yes, there are some charlatans who sell floobydust)* die quickly, but others open questions that spawn new areas of development, such as digital jitter reduction (yeah, you can hear that, too), power supply improvements (Walt Jung, where are you?), etc. I recommend reading an issue or two of *Audio Amateur*, *Glass Audio*, *Stereophile*, etc.

The whole art of audio is about expanding the choice and ability to introduce (or not) anything that wasn't there in the performance. How close are we toward that objective? I'd say we're still a long ways from making you believe that there really is a drum set in your living room. Think about for a moment: 5 drums, 10 vibrating heads, and 4 cymbals, each aimed in a different direction, perceived through 2 loudspeakers. The world of audio for pleasure (as opposed to function, like your phone or PA system) is an ART that balances what you see on your test bench, with what you hear. Anyone who has been down that path will attest to that.

It is understandable that those who live and die by measurements are skeptical because they've never played in this area, and the reported audible results will challenge commonly-held engineering notions. Don't get me wrong, most of them are explainable (eventually). So you can pass judgment, but it will be valid for you only after you've honestly put your UNUSED test instrument, your EAR, into service. And, by the way, people do ABX comparison tests, however, it's more complicated than you think because switching will degrade the audio signal, oxidized contacts and all that, old chap. Enjoy your VW.

GEORGE KAYE

George Kaye Audio Labs.

New York, N.Y.

* Note, "Floobydust" just means miscellaneous, not weird junk. I don't know anyone that sells floobydust.—RAP

Well, as soon as I read all of this, my "emotions began to stir," and it was

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not art causing that. I do not think Mr. Kaye should call me "my friend" because I am NOT his friend.

Taking the last topic first, the relays in ABX boxes do *not* have to cause distortion because of "oxidized contacts." Silver contacts are used for high-current paths because the wiping action of the relays breaks through the oxide, every time you operate the relay. For low-level signals, gold relay contacts are used specifically because gold does NOT oxidize. So don't try to confuse *me* with bad science, *old chap*. If you think you can hear the "distortion" caused by a relay placed in series with a speaker wire, I'm sure some people would be *happy* to set up a comparison test.

(For those of you unfamiliar with ABX testing, it's a switch box that lets you perform comparisons on two items—amplifiers, speakers, speaker cables, etc. If you push button "A," you are connected to, for example, speaker cable A. Pushing button "B," connects you to speaker cable B. And pushing button "X," connects you to a random choice of either cable A or cable B. See "What's All This Hoax Stuff, Anyhow?" in the April 4, 1994 issue for more details.)

I do not want to get into any argument about vacuum-tube amplifiers versus solid-state amplifiers. If I can't hear the difference and Mr. Kaye can, that doesn't bother me at all. Hey, I have tried using my ears. They are adequate for ordinary listening. I can hear what I need to hear. But I cannot hear and appreciate every little nuance. Hey, I have tin ears. And I am neither proud nor ashamed about that. It's just a fact. I probably ran too many lawn mowers in the last 40 years.

If Mr. Kaye finds that an amplifier with 0.25% distortion sounds *better* than one with fancy 0.0003% specs, I have no doubt he may be right. I am perfectly prepared to agree with Mr. Kaye that our new CD standards are imperfect. I am only going to argue with Mr. Kaye about wires and cables.

I am prepared to agree that when speaker cables have significantly different characteristics such as L, or C, or series resistance, they may sound different. However, I am prepared to

argue that if they have the same characteristics, they are likely to sound the same. And there are a LOT of cables that have about the same basic characteristics—and they probably sound alike—despite esoteric claims.

But Mr. Kaye wants to argue that "...different is always different." As he is a professional salesman and promoter of high-end audio, I am not surprised to hear him say that. But my rebuttal is to respond: "Different is different, ONLY IF the difference makes a difference." You can say that you like superior speaker cables, but if you can't tell the difference—if you cannot hear any significant difference—then how can you argue? You could say that silver wires are "different" than the best copper wires. But, if there is no measurable difference, and no audible difference—and the difference can be computed to cause much less than 0.1 dB of difference—maybe the difference is *not really* a difference...

When Mr. Kaye argues, "But what harm does it do?"—that's where we part company. I am prepared to concede that some audio components may indeed have audible advantages. So if a salesman of high-end Audio Equipment sells to any customer, whatever he wants to buy, that's one thing. But if a salesman counsels his customer that one set of speaker cables provides "better soundstage depth," and another one has more "transparency," well, that's his problem. He can sell rich yuppies the Emperor's new underwear, or the Emperor's new sandals, or the Emperor's new speaker cables. He can sell them anything he wants to. He can sell them silver speaker cables and silver ac line cords (yes, people *do* sell such stuff) that cost many *thousands* of dollars. He has to live with his conscience—that's his problem, not mine.

I won't say that the regulators or amplifiers or converters I recommend to my customers do not have some subtle or hard-to-measure characteristics that are quite good, but mostly we sell our parts on their merits, in terms of tested and guaranteed specs. We think our customers get their money's worth. I can live with my conscience.

Mr. Kaye can buy any cables he wants to. He can spend his money anywhere he wants to. He can counsel his customers to buy any equipment he wants to. And if the customers decide to buy it, it's none of my business. It is not my primary task to prevent every starry-eyed puppy from being separated from his \$\$\$.

But when Mr. Kaye argues that he can tell subtle differences in cables that are really trivially different, I have to be skeptical. When Mr. Kaye says I should trust him—I won't.

One other reader, who often collaborates on high-tech, high-end audio projects wrote in to observe, "Bob, you don't have any credibility on high-fidelity audio."

It is literally true that I am not a person who says, "I can hear that these well-burned-in interconnect cables, connected between my tuner and my amplifier, sound much better, and have much better clarity than any old cables." If I don't go around saying preposterous, incredible things like that, then you might say I don't have any "credibility."

But if you acknowledge that I am capable of suggesting a reasonable experiment, so that any person can figure out for himself if the interconnect cables are capable of making any audible difference—then maybe I do have some "credibility."

I mean, do you really think that installing three feet of super-fancy interconnect cable between a tuner and an amplifier can cause any significant, audible improvement or difference? If one cable has 36 pF and another one had 50 pF, and if the tuner's audio output impedance was 600 ohms, that would cause a change of frequency response as big as from 7.3 MHz vs. 5.3 MHz for f_{3dB} . The difference in phase shift at 730 kHz might be 2.2 degrees. The phase difference at 73 kHz might be as big as 0.22 degrees. The phase difference at 20 kHz might be as big as 0.06 degrees.

Do you think anybody can hear that difference on an audio channel? Do you really think an interconnect cable between your tuner and audio amplifier can add significant smoothness or clarity? Can you hear an improvement after the cables have been "burned in?" Can

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you hear the molecules in the copper, after they have been realigned by burn-in and stress? Can you hear the absence of corrosion in 22-k gold-plated connectors?

Do you think that ANYBODY can hear such a difference? If anybody says they can hear a difference, would you like to be able to challenge them to an ABX test?

Do you argue, "What harm does it do?" when some self-proclaimed "expert" tries to sell some fancy interconnect cables, when the only audible difference is—the salesman's fatuous words of praise?

NOW, I have mentioned in my old columns³ that "Audio Experts" claim they can hear the difference between good speaker cables and "better" ones. One guy claimed he can even hear a difference if there are splices⁴ in the cables. Other guys say that the expensive cables provide better "presence." Advertisements claim that these expensive specialty cables provide better "sound-staging." Better "harmonic integrity." More precise "imaging." More fluid highs. "Less skin effect." I shall not comment further on these claims.

But an engineer, Tom Nousaine in Illinois, set up some comparisons between some high-end speaker cables costing \$418 and \$900, versus some 16-gauge zip cord, at 18 cents per foot. He used an ABX box for ease in conducting double-blind comparisons. The audiophiles were confident that they could clearly hear the superiority between their uniquely excellent speaker cables, in their own home audio systems, versus the cheap wire.

After many careful tests—double-blind tests—the audiophile experts had to admit they couldn't hear any difference. "The differences become vanishingly small." "They sound identical." They were devastated. "Following the session, Mr. B. was crushed, likening the experience to that of finding his wife in bed with another man." After 10 sets of trials, there was no (statistically valid) indication that the Golden Ears could tell whether the cables they were listening to were the \$900 cables, or the \$9 cables.

All of the parties agreed that the

relay contacts of the ABX box did not cause any significant error, as they were transparent compared to straight-wire bypasses, and the box did not cause any error.

These tests were written up by Mr. Nousaine and published in *Sound & Vision*, a magazine published in Canada. You can buy this magazine by sending a check for \$2.95 (U.S.) to *Sound & Vision*, 99 Atlantic Avenue, Suite 302, Toronto, Ontario M6K 3J8, Canada. Postage to Canada is 46 cents per 0.49 ounces in 1996. Ask for a copy of Volume 11, Number 3. They'll know that there is a lot of interest in Mr. Nousaine's story.

If any of you are tired of being told about the superiority of expensive speaker cables, you'll want to read this taste-test. Maybe the Emperor's new sportcoat is transparent, after all! Note, Mr. Kaye thought I should subscribe to *Audio Amateur*, or *Glass Audio*, or *Stereophile*. I'd rather spend my money on a subscription to *Sound & Vision*.

Mr. Nousaine indicated that at the beginning of the tests, some Audio Experts tried to duck the question of, would they like to be involved in the comparison testing. They tried to explain, "It sounds better with better cable. It must make a difference because everybody says it does." After publication of these tests, it may be a little bit harder for these guys to keep on arguing this...

Mr. Nousaine has since run many other tests—dozens of ABX tests. So far, no one has been able to hear any significant differences between cheap wire and fancy speaker cables. In fact, Mr. Nousaine has laid out a challenge, with no takers yet: If you can hear the difference between your fancy speaker cables and cheap wire, you win \$1000. But if you can't hear the difference, he gets to keep the expensive speaker cables. Mr. Nousaine has also run many tests that show similar results for "audio interconnect" cables. No one can hear the difference between the best and the cheapest ones, notwithstanding all the fancy claims.

I do not want to get drawn into a long argument about "subjectivism," which is the premise that whatever

sounds good is right, and nobody can talk you out of it. Mr. Doug Self has done a very fine job of defining the reason why scientific types are not supposed to be able to criticize and disagree with subjective observations. I will simply quote Mr. Self's best definition of the "Subjectivist Manifesto":⁷—"Objective measurements of an amplifier's performance are unimportant compared with the subjective impression gained by listening tests. Where the two contradict, the objective results may be dismissed...It therefore follows that degradation effects exist in amplifiers that are unknown to orthodox engineering science, and that are not revealed by the usual objective tests...Considerable latitude may therefore be employed in suggesting hypothetical mechanisms of audio impairment, such as mysterious capacitor shortcomings and subtle cable defects, without reference to the plausibility of the defect, or the gathering of objective evidence of any kind."

In other words, if a guy says he can HEAR the difference between two amplifiers or two cables, we are not permitted to contradict him, nor to try to measure any differences or similarities. And if we want to put that person to a test of proving that he can really hear a difference—we can't force him to do the test. And if the test results show that he cannot really hear any difference, we are not permitted to doubt his excuses.

Explanations such as, "these oxygen-free wires have better distortion at the sub-molecular level, greatly superior to the noise and distortion in ordinary wires which is manifested by tiny micro-bursts of noise just below the threshold of audibility or measurability" must be accepted, and cannot be questioned. Yeah, sure.

I still think that Fred Davis' article on "Speaker Cables, Testing for Audibility"⁵ is one of the best technical explanations. And I really like Fred's proposal, that the broad array of 32 flat twisted pairs of cable, such as Spectra-Strip 843-138-2601-064, with all the wires appropriately "paralleled" is one of the best speaker cables. Because when you have 32 cable pairs, and each one has about 75

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ohms, the impedance of all 32 together is down near 2 or 3 ohms.

This does give very low phase shift from the amplifier to the speaker. It gives good damping. It also gives low skin effect. And it is inexpensive. And it is flat enough to place under rugs, which you cannot do with big, fat, expensive cables.

Some people might say, "But such a cable must have a lot of capacitance." Well, IF you go around leaving your speaker cable disconnected from any speaker, yes, it might act as if a big capacitance—perhaps as big as 0.016 μ F for 20 feet. BUT if you connect it to a 4-ohm speaker, it just looks like a few ohms. There ain't no pF—just as when you terminate a long 50-ohm cable to its characteristic impedance, it looks resistive. Conversely, such a cable has a lot less *inductance*. In general, it has lower impedance, and is better suited to the task of coupling from an amplifier to a low-impedance load. Ordinary pairs of speaker wires are typically closer to 70 or 90 ohms, in their characteristic impedance.

Other people argue that the inductance of a speaker can cause a lot of phase shift. Even when a speaker cable's impedance is low and ideal, it can cause phase errors when driving a load—a real loudspeaker—if that looks like L in series with R, such as 100 μ H in series with 4 ohms. This would appear to be a problem.

But, if you put a series R-C network parallel to the R-L load, such as 4 ohms in series with a 6 μ F Mylar—that can cause the overall impedance to be nearly flat, and can cut down on the phase shift caused by speaker impedance. This works best when $L/R = R \times C$. This is called a Boucherot cell.

One article⁶ argued that skin effect can cause a nasty little tail of error if you apply through the speaker cable to the speaker a brief transient—such as a tone burst of a few cycles of a sine wave. These transient errors may be more audible than a mere phase error on a continuous tone sine wave. And they are fairly easy to measure with a 'scope. However, nobody said these differences are SIGNIFICANT. And the analysis never indicated how

much of the error is due to cable inductance, and how much to Skin Effect. In the real world, it may be hard to tell.

I wonder if Mr. Kaye can actually show us some characteristics of "oxidation with diode-like threshold voltages" on old RCA connectors, as he mentioned in his letter. Does that mean that some small signals just do not get through? I'd love to play around with one of those. But I cannot say that cold-soldered joints do not ever exist.

I sent George Kaye a copy of Mr. Nousaine's article. His comments were quite limited. But he did admit that while he can hear the difference between different speaker cables on some days, he may not be able to hear the differences on any particular day. In other words, differences that he enthusiastically considers clearly significant on one day, he may not be able to distinguish on another day. So there's no point in trying to give Mr. Kaye an ABX test. (So if you are going to challenge a friend to an ABX test, don't show him the Nousaine article first, because he may try to weasel his way out.)

I asked George Kaye to tell me what kind of speaker cables he liked. He demurred, saying that he liked and used many different kinds of speaker cables. In other words, he refused to be trapped into saying there was one kind of cable he preferred. If there were such a cable, I would surely try to emulate its characteristics, using perhaps some Spectra-Strip cable with some added R and L or C. But if he won't name a type, I can't do that. Maybe it's just as well that Mr. Kaye does not live just down the street from me, so I can't challenge him to an audio test. I can't literally challenge you readers to an audio test. But I can challenge you to *think*. Mr. Kaye, I'm not so sure about.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:
Mail Stop D2597A
National Semiconductor
P.O. Box 58090

Santa Clara, CA 95052-8090

P.S. I recall that a few years ago the Bay Area Skeptics (Bay Area Skeptics, 177723 Buti Park Court, Castro Valley, CA 94546), along with an Audio Engineering Society, ran a lecture and ABX comparison in Berkeley. In that case, a couple of guys who claimed to have good ears were able to hear some consistent difference between some 22-gauge lamp cord and some good cables. However, most engineers admit that cables that have about the same R, L, and C tend to sound alike. Cables that have markedly different R, L, or C can have significantly different phase shifts, and might sound different. So maybe we should propose an ABX test of a capacitive speaker cable, not versus a plain piece of lamp cord, but versus a piece of lamp cord with 0.01 μ F on its output. Or compare an inductive speaker cable set to a piece of lamp cord with a few hundred microhenries in series with its output...Hey, let's have some fun!!—RAP

References:

1. "Bob's Mailbox," *Electronic Design*, July 24, 1995 p.105.
2. I have not recently put together a 1 μ F capacitor made of NPO ceramic or silver mica, but I bet if you drive a 1-kHz square wave into these capacitors, they will not "sing." It is not true that "all capacitors are microphonic." It is just that most capacitors that Mr. Kaye is familiar with, are microphonic.
3. "What's All This Hoax Stuff, Anyhow?," Robert Pease, *Electronic Design*, April 4, 1994.
4. "What's All This Splicing Stuff, Anyhow?," Robert Pease, *Electronic Design*, Feb 1991.
5. "Speaker Cables—Testing for Audibility," Fred E. Davis, *Audio*, July 1993, p. 34-43.
6. "The Essex Echo," Malcolm Omar Hawkesford, *Stereophile*, October 1995. p. 53-64.
7. "Science vs. Subjectivism in Audio Engineering," Douglas Self, *Electronics & Wireless World*, July 1988, p. 692-696.



BOB'S MAILBOX

Dear Mr. Pease:

...Recently, for simple edification, I designed and built a machine that would balance not only a single inverted pendulum (a classic control problem), but also a doubly articulated inverted pendulum, in one plane of motion, by controlling the base position of the bottom-most pendulum. That experience has reinforced my original thoughts on this subject.

Simplified explanations of the Fuzzy-Logic method, as I read them, describe a way of generating high-order polynomial relationships—between the measurable system “state” variables and the controllable system response variable(s)—WITHOUT THE DESIGNER KNOWING or HAVING TO KNOW specifically what this polynomial is. This is the supposed strength, i.e., using general intuitively-derived relationships, between controlling variables and desired responses, to meet system requirements. This obviates any need to specifically write down and program the polynomial equation into a conventional digital microcontroller (like a 68HC11).

The real problem, however, is in picking the coefficients (i.e. the constant values) required in these relationships. Whether one derives these mathematical relationships from fundamental physical principles, or using a Fuzzy-Logic design software package with pull-down menus and SVGA graphics, the designer has to choose not just the form of the polynomial, but the specific coefficient values as well. And it usually turns out that solutions to your most “important” control problems require a system response very sensitive to coefficient selection.

A coefficient change of 10% can be the difference between something that works and something that doesn't. The number of possible selections becomes larger than trial and error can reasonably accommodate if two or three such coefficients are involved in a solution.

Based on my recent experience, it is

best to use fundamental physical principles to mathematically model the situation approximately. Then use this in a simple predictive/correction control scheme—which MAY WELL be inspired by experience and intuition (e.g. a PID method). The physics of that situation will dictate most of the coefficient values—with perhaps one left over to control overshoot or damping. Programming the equation itself is a very minor part of the design effort. Corrections can then be made based on some quantifiable physical principle!

Fuzzy-Logic methods and software would seem, at best, to remove some of the algebraic overhead required to implement an intuitively-based trial-and-error approach. But, as indicated above, difficult problems are not best approached in this way. And easy problems, by definition, require few trials, and might be simply solved using conventional \$2.00 microcontrollers—hardly justifying the acquisition of extraordinary Fuzzy hardware/software.

The point here is not to take a knowledge of fundamental physical principles, or the designer's cleverness out of the feedback loop. The Fuzzy-Logic approach implies this is not needed, that point and click is good enough. What the Fuzzy technique adds is a minor convenience. What it omits constitutes a major deficiency.

In that regard, I include a video tape of the doubly-articulated-pendulum balancing machine, described and demonstrated for your edification. Do with it as you will. I seem to recall one of your past Pease Porridge articles indicated that such doubly-articulated pendulum control would require state-of-the-art DSP processing to implement. This machine requires a 68HC11E2 using 40 bytes of RAM, 1 kbytes of assembler-coded PROM, running at 1/3 of its 2-MHz capacity. The algorithms used are more important than the processor—Fuzzy Logic or otherwise.

MICHAEL D. MILL

Seattle, Wash.

Michael, most Fuzzy promoters

claim that it's easy for them to do something that's hard for other people. You and I have shown this is not true. I agree completely that picking the right algorithm, or the right architecture, is critical. And picking the right coefficients is nontrivial. And engineering good sensors may be even harder—and more important! Still, after we get it working, nonlinearities such as those facilitated by FL may be useful in a system.—RAP

Dear Bob:

In your March 4 Mailbox, Walter Gately asks in his letter, if Robby the Robot's appearance in the movie *The Forbidden Planet* was "...the earliest recorded instance of artificial intelligence using Fuzzy Logic." Your answer, while amusing, did not directly address his question. The answer is no.

The earliest documented example of artificial intelligence using Fuzzy Logic is contained in Isaac Asimov's report on a robot named, as it happens, Robby, first published in 1940 under the title "Strange Playfellow." It was later republished in Dr. Asimov's collections of papers on the development and uses of artificial intelligence, both with and without the use of Fuzzy Logic, called "I Robot." An earlier attempt at artificial intelligence using clay as the construction material does not qualify, as the *golem*, as it was called, had no apparent intelligence at all. (It might be argued that the earliest attempt at constructing an artificial intelligence from clay, as detailed in the report *Genesis*, author unknown, was also a failure, but that is a research project for another time.)

I realize that this attempt to clarify this issue might escalate into a war of "they were first" claims, but I felt it necessary to take the chance.

K.A.BORISKIN

Bellingham, Mass.

Was that "Robby" a real robot or just a SciFi writer's conception? Either way, the ability to use a gray scale,

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rather than just 1/0, is an old analog concept, and is not necessarily Fuzzy Logic. Maybe Professor Zadeh would like to comment on whether Robby's concept antedates FL... —RAP

Dear Bob:

I just reread your column on Carpal Tunnel Syndrome in the Dec. 5, 1995 issue (plus the letters in response) and noticed there is an awful lot of ignorance out there. I know a lot about it because I HAD it and I had to learn.

First, one of your readers said that "...it's not what we do, it's the angle we do them at." That's really not true. It's actually the fact that we keep doing them continuously at the EXACT SAME ANGLE that causes the problem. Second, the typing version of carpal tunnel comes from more than one cause:

As your fingers are suspended above the keys, the tendons must apply a slight, but CONSTANT pressure up (check it and see) to hold position. This is the main culprit. Also, the fact that your wrists are usually rested on the desk in front of the keyboard during idle times makes your wrists cold and reduces blood flow in the same way a cold pack reduces swelling—leading to other problems. The bottom line is that good wrist pads ARE the solution—Mr. Boyd's comments notwithstanding.

I would like to snap a photo of him with his "...arms in line and his fingers curled like a question mark," to put on my wall at home next to the cage where I keep my pet Praying Mantis. Note: A good wrist pad DOES put your arms and wrists in line if your table and chair are the right height.

CHESTER SIMPSON
National Semiconductor Inc.
Santa Clara, Calif.

Chester, your point is, what works well for one person—wrist pads or no wrist pads—may not work well for another. Point well taken.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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WHAT'S ALL THIS HOLLERING STUFF, ANYHOW?

Listening to the radio this morning, I heard Assistant Secretary of State Richard Holbrooke talking with one of the interviewers on National Public Radio. He said he did a lot of interceding between the Serbs, the Croats, and the Bosnians at the diplomatic talks in Dayton. He said sometimes he did a lot of hollering, but at other times he played the Good Cop and Secretary of State Warren Christopher did the hollering. He said he doesn't holler much when he calls on the Pope, or when he is visiting with Deng Shiao Ping, but in some quarters, it's the right thing to do. He indicated that if he hadn't done all that hollering, the Dayton Accord would never have happened....

Well, I perked up my ears when I heard him say that, because sometimes I do a little hollering. Ever since I heard it's bad for your health to just let your anger come to a boil—and bottle up the frustration inside—I let the anger build up,

and then I do some hollering. Not necessarily *at a person*, but about a situation.

Like the other day, when the mailroom forgot to pick up our mail for three days in a row. When I pointed this out to the mailroom, they said they would come and pick it up. Then

when they didn't pick up the mail, I went down to the post office, bought some postage, and moved out the mail myself. And on the way, I did a little hollering at some guys' voice mail. My boss complained that I should not holler so loud. Maybe so.

I remember when Bob Swanson was our group executive at NSC. Sometimes he would get on the phone and just start hollering. And he usually stood up so everybody could hear and see him, too. I figured

Ideally, we should not have to holler at anybody. The question might be, when a person is trying the patience of a Saint, when is the Saint justified in hollering?

out what he was doing. I don't remember any particular arguments, but it was plain to see that if anybody was going to try to screw our group, they would hear from HIM, good and loud. I quickly realized that Mr. Swanson was going out of his way to look out for the good of our group, and he wanted us to all know about it. And I really appreciated that.

Now Mr. Swanson is at LTC. I've heard that he still does a good job of hollering at people. However, there's one discrepancy: While he is more-or-less an equal-opportunity shouter, he

almost never hollers at women. I guess he feels that's not quite right. Maybe so.

I remember a few times when guys hollered at me. One time I inherited a test problem, and as soon as I heard about the problem, I went down to the test floor to start solving the problem. Don Bergren, the test manager, came by and explained to me GOOD AND LOUD that he had to put up with a lousy test circuit. He said he was wasting lots of time because the tester kept giving stupid answers, and the engineers should give him better tests than that.

Of course, I just inherited that problem an hour before, so it wasn't exactly fair for Don to holler at me about somebody else's bad tester. But I figured Don was hollering for effect, so I agreed with him that he was right. I indicated that he had a perfect right to holler at me, and I'd clean up the testing really fast. And I did. But I certainly wasn't going to shout at Don and tell him not to shout at me—because I knew he was doing his job. Being shouted at isn't always exactly fun, but it can be part of the game.

Just the other day, I was hollering about a guy who owed us some samples of reject parts. I had figured out that when he could easily give us what we wanted, he gave us what we asked for. But if any problem arose, he used that as an excuse to do NOTHING. In this case, we had asked for 500 rejects so that we could evaluate the tester. He said he didn't have 500 rejects because the yield was too good. So he sent nothing, which annoyed all of us. He could have sent us 110 bad parts, but he did nothing.

Later that day, one of the secretaries asked me, "Bob, were you hollering at a meeting in room D-2-7 this morning?" I thought about it, and said no. She said, "I went past D-2-7 this morning and it really sounded like you were hollering at somebody." A thought struck me. I asked her, "You mean this morning about 11:30?" She said, yes. I explained, "Yes, I was hollering this morning, but I was in our office area—right here." Here is about 200 feet from room D-2-7. She

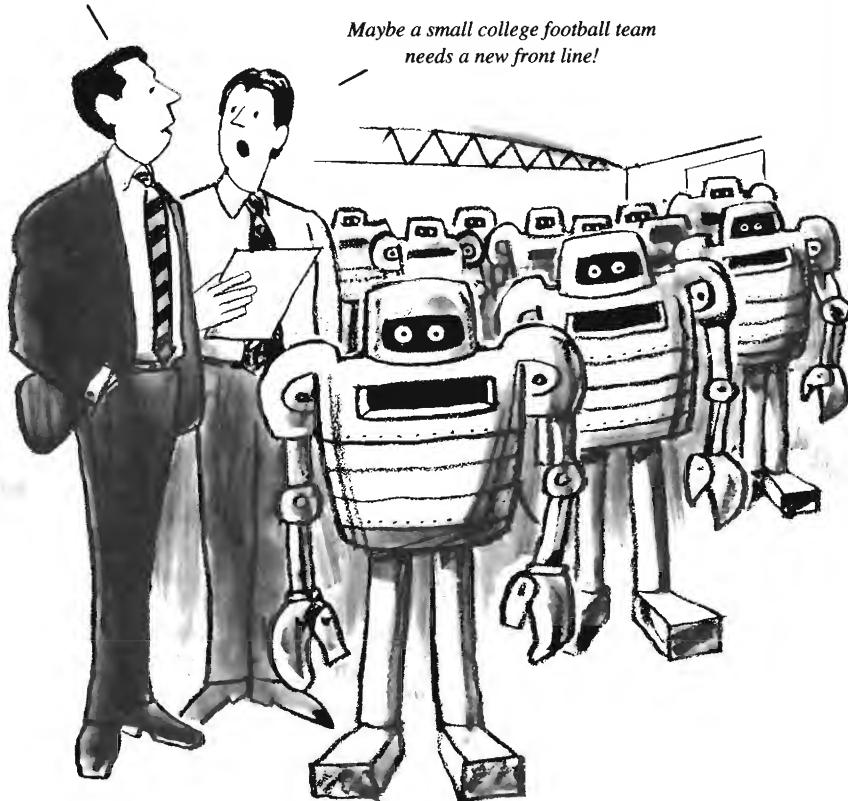


BOB PEASE

OBTAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

hollering. Not necessarily *at a person*, but about a situation.

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seemed a little skeptical. So I asked a couple of the engineers if they had heard me hollering, and they said, "Oh, yes, you were right HERE." I explained that I didn't want to do any harm to the telephones; I was just hollering so this guy 6000 miles away could hear me without a telephone. Finally, she began to believe me. Anyhow, that was the best compliment I got all week.

Ideally, we should all be, like, sweetness and light. Ideally, we shouldn't have to holler at anybody. The question might be, when a person is trying the patience of a Saint, when is the Saint justified in hollering? Never?

We'll debate that later. One of my friends, after reading the first draft of this, commented that maybe some of the Saints did some hollering, for example during their actual martyrdom. But she was a little skeptical of my qualifications as a Saint. "Saint is a long way from the first word that comes to mind when I think of Bob Pease. Please send \$50.00 for a list of the first 200 words." I told her the check is in the inter-office mail.

Another colleague pointed out that several other executives at NSC were, well, outspoken. "Nelson Walker used to holler a lot, and Ed Pausa's voice carried so that they had to put another office between his and Charlie's." The key to effectiveness, he proposed, is to calm down once the hollering is done, and get on with it. Sounds reasonable.

But I'll let Mark Levi have the last say: "We holler when we care. We holler when we have a passion for doing something right, or when we are trying to keep a commitment to a customer. Sometimes, hollering is the only way people know you really care. People who don't holler are wimps." I really couldn't have said it better myself.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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PEASE PORRIDGE



BOB'S MAILBOX

Dear Mr. Pease:

I was a little bit disappointed when I read your solution in the April 1 issue for the quiz in the March 15 issue—finding the base-collector voltage with a breaking-down reverse-bias potential. You said, "When you break down or 'zener' the emitter, it emits light. Red light... This light shines through the silicon lattice and causes enough photocurrent in the c-b junction to force the collector negative."

I don't think you answered your question well because you did not explain HOW the light was created, WHY the light was a red light, HOW the light generated a current through the base and collector, WHY the magnitude of the base-collector was 1/10,000 of the reversed emitter current, WHY the collector potential was negative, or WHY the magnitude of the base-collector was 0.4 V. Would you prove these quantitatively?

I can not explain why the red light was created, but I think that the photon creates extra pairs of holes and electrons; the strong built-in electric field created by the diffusion process at the base-collector junction will drive the electrons in the n-type collector and holes to the p-type base. Therefore, we see a current when the base and collector is connected by the meter. I guess that the magnitude of the current must be related to the photon energy generated by the breakdown reverse bias, and the base-collector current proves that there is a potential gradient in the open-circuit base-collector junction.

NICK RHEE

E-OIR Measurements Inc.

Spotsylvania, Va.

Hello, Nick. Well, I think I answered the question well enough to suit ME. If you have more questions, you'll want to ask somebody else, such as a device physicist, because I don't know all the DETAILED answers, just the BIG picture. Besides, some people say 2N2219s glow GREEN. I don't know; I'm slightly color-blind. —RAP

Dear Bob:

I, too, drive an old car to NSC everyday. A 64.5 Mustang that I would say is the dirtiest/ugly vehicle at the plant.

I do keep it very mechanically sound, though. I have approximately 7000 hours on the current engine, and it's beginning to burn some oil. So, it's time for a new engine, but otherwise everything is fine with it.

We have both heard the news that our cars may be forced off the road due to new pollution laws, etc... My question to you is how much environmental damage is caused in the production of a new car? I am wondering if it would be more environmentally friendly to keep the old cars on the road than to produce a new car? I don't have a feel for it, but with your resources maybe you could come up with an answer?

SKIPPY

Via e-mail

To get rid of pollution, you can FORCE a lot of people to buy electric cars instead of Fords or Toyotas. But it would be cheaper for the state to buy up old polluting junkers, and GIVE the driver a new Cadillac. That's because the amount of pollution saved by an electric car vs. any new car, is TINY compared to the amount of pollution abatement of a big car vs. an old gross polluter. At this time, I have not seen anybody who can "quantify" the amount of pollution generated by manufacturing one new car, compared to a bucket of smog, or a basket of nitrous oxide.—RAP

Howdy, Bob:

On that brouhaha about leaving computers on all night, mine's been on since I bought it in '88, except for a motherboard change and a couple of office moves.

And it ain't been a-wastin' no electricity, neither. It's been thinkin' as sure as the dog's been woofin'. I've been op-tee-mizing some of the most fandangle equations you ever did see.

Plenty of thinkin' to be done by your

readers, too, ayup. You can play one-move-a-day chess, or calculate that there traveling salesman problem, or smash two galaxies together, or even figger out a really fine prime number, but don't ever go turning off that computer.

Anyone who doesn't run their computer overnight hain't been doin' enough thinkin'.

PETER SKYE

Possum Holler

(aka Glendale, Calif.)

One reader pointed out that Hard Drive bearings are more reliable when just left ON. But I'm not sure about the HEADS. I eschew Hard Drives. I just use floppies. A Hard Drive is merely a place to put files into UNTIL it dies. I've been writing columns for 6 years and barely filled up 5 floppies. (Obviously, I don't use modern hog-in-the-trough computers.)—RAP

Dear Bob:

I read with some surprise your comment where you thought it would be just as good to leave a PC on continuously rather than shut it off at the end of each day. I value your opinion greatly, but I had to question this recommendation.

The implication of this recommendation is that the MTBF of components is no different whether individual components are powered up or switched off. I have never been a reliability engineer so I don't feel I am an authority on this subject, but surely any component that generates heat will fail sooner if it is powered, and any mechanical component will be wearing out faster while running than at idle. Also, how about those high-voltage components in the monitor? Surely the internal voltage stresses can make a component age and fail faster? Also, if there was no difference in a powered-up condition versus a non-powered condition, then why do most manufacturers perform "burn-in" before a product is shipped out, and perform MTBF tests on equip-

PEASE PORRIDGE

ment in a powered-up state?

When I worked at Unisys Corp. in their disk-drive section, we used to check out MTBFs of drives by putting, say, 20 drives up on test with software that continually performed random seeks. Every PC contains at least one hard disk drive! At the end of the 1980s, drive MTBF increased greatly and the drive was no longer the "weak" link in PCs, but this is a mechanical component and, to my thinking, will fail sooner if powered up 24 hours per day rather than 8 hours per day.

The issue of powering a drive on and off used to be a concern with regard to disk surface damage, but drives now are pretty rugged and use a combination of landing zones and improved materials, so this will not be a concern in normal situations. However, we did use to test this at Unisys—several drives were left running on a rack that powered the drive down and back up again every two minutes. WE never had a drive fail due to being powered up and down frequently!

As a final note on this subject, even if we decide there is no real advantage in reliability if computers are turned off at night, how about turning equipment off at night for the sake of the environment and future generations? If light bulbs had infinite life, would you leave all the lights on in your house all the time, Bob?...

ANDY BENTON
Additional Dimension Inc.
Flemington, N.J.

Mr. Benton: If I turn off my computer - or my lights - I just have to turn on my heater. Here in San Francisco, it's cool, day and night! If I turn off the lights, the hydro plant would back off, and the water would just spill over the dam at Hetch Hetchy! And, I still say, modern systems built with good parts, do NOT fail as predicted by MIL-HDBK-217. A little heat or a little voltage does NOT cause significant failure rates.—RAP

All for now. / Comments invited!
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READER SERVICE 109

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WHAT'S ALL THIS TRAINING STUFF, ANYHOW?

Over the years, the British Royal Navy always had a good number of ships. In 1796, about 600 ships were in their fleet, including Ships Of The Line, Frigates, and Sloops. All powered by sails. In 1896, there were about 220 ships—all steam-powered. Those numbers are approximate, per my 1894 *Encyclopedia Britannica*.

In those days, every ship needed a navigator. You couldn't go out on the open seas and get where you were going without a good navigator. So every ship in the Royal Navy had a Navigator. Young gentlemen spent

five years in the Navy's War college, getting a fine education. After graduation, Navigators were typically assigned to small ships, and after considerable seasoning, became qualified to be the Navigator on a Ship Of The Line.

A Navigator was entrusted with a ship worth hundreds of thousands of pounds, with hundreds of sailors. Everybody respected the Navigator. The enlisted

men couldn't just overpower the officers, and mutiny, and kill or cast off the Navigator. Without the Navigator and his five years of education, they would never get home. So, the mystique of the Navigator was one contributor to the stability of life aboard ship.



BOB PEASE

OBAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

About 1936, the Royal Navy faced a serious problem. With the winds of war whipping up all around Europe, the Royal Navy had to make plans to expand. The Navy would need hundreds of new ships. And, thus, it would need hundreds of new navigators. Ahem....

How could the Navy get hundreds of navigators in such a short time? If the lead time is five years, then they would have had to start training educating their navigators two or three years previous to that. What to do?

In the end, pragmatism won out over tradition. Bright young men good at math and science were thrown into a newly-planned crash course in navigation. After six months, some pretty good navigators came out of the Naval College and were assigned to ships. Perhaps these navigators were not quite as well-grounded or well-rounded as the traditional ones, but they received some very good training. They were supplied with good reference books, good tools, sextants, and charts, and with good radio navigational aids. The advent of radar didn't do any harm. So when war came down on Europe in 1938, the Royal Navy had lots of problems, but a shortage of Navigators wasn't a significant one.

John Christensen, one of our Applications Engineers who is an experienced sailor, pointed out that any good Community College can teach you a course in navigation in six or eight weeks, with just one evening of classes per week. Any fairly thoughtful person can, with a small modern calculator, master the art of navigation in a *whole lot* less than 6 months.

In fact, John said he taught his wife Felicity the art of navigation in one morning. However, that's an unfair comparison: She is intelligent, and

John was sober (or so he claims).

Here at National Semiconductor, we have some very good training programs. We also have, as I'm sure you'll suspect, some mediocre ones, and a few outright lousy ones (remember "Apples and Oranges"?). Still, our training programs have expanded, and the number of things you can learn cover a wide range from Solid-State Physics to The Path of Dialogue, from Digital Signal Processing (DSP) to Doing Business in India (or China or Japan). We have 8-D Problem Solving, and we have Electronics for Non-Technical People. There are courses in Team Leadership, and in Team Followership. (Heck, if you have a team with "All Chiefs and No Indians," that usually doesn't work well.)

Still, every time I see a catalog of courses from our Training Center, I think about trained bears. And trained monkeys. Yes, training is sometimes suitable for animals. And sometimes it's suitable for people to do certain jobs. But, as you may have noticed by now, I prefer Education. I like to see people think about what they're doing and understand it so when something goes wrong, they can figure out what to do, or call in the right experts. If the guys at Chernobyl were EDUCATED instead of merely *trained*, would they have made less of a botch? Or at Three Mile Island? (Maybe they were educated *just a little*, and we should all be aware that a *little* education is a dangerous thing...)

I was recently invited by our Training Center to help plan the training of technical people in various analog techniques. First, we were told we should make some plans to have an Analog Forum, so that Analog Experts could lecture to Analog people on Analog topics. Some parts of that plan sounded like good ideas, but we really have to make the program open to all NSC employees. People who have never worked with analog circuits or analog systems need to learn about this strange analog world. Okay, I got some approval on that.

Next, I'll have to go discuss with our Training experts, Sharadon Smith and some other people, the idea of offering some Analog Education. I can't think of many things I know that I could TRAIN people about Analog. But there are a lot of topics



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where I might *educate* people.

Sharadon and I aren't far apart, not in any big disagreement, as we discussed by phone and e-mail. We agree that there's a continuous spectrum of gradations between *training* and *education*, and we're interested in all of these, as appropriate. We agree on the need for *learning*, so that people can apply their knowledge—especially in ambiguous or unexpected situations where you can't expect training to tell you what to do. That sounds like *education* to me.

We also agreed that any such learning is best when you can start using it right away. Education that will only be useful in the far future isn't likely to stick and may be of doubtful value (don't get me started on how I took Fourier Analysis as an MIT freshman, and that it wasn't until a couple of years later when my engineering instructors told us it was supposed to be *useful* for something....)

Don't take what I said the wrong way, though. If kids are learning to drive, they need Driver Training as well as Driver Education. They need to learn situations on when it's correct to slow down and *think* about a problem. They also must learn when thinking or cogitating is **WRONG**, when they must respond reflexively, and do what they trained themselves to do. If a dog jumps out in front of you on an **EMPTY** freeway, you do one thing. If a dog jumps out in front of you on a **CROWDED** freeway, you do something different. If a **DEER** jumps out in front of you, you do something different yet. You must know in advance what to do in each of these cases.... I wrote about this back in December of 1991, and I'll write about it some more in a few months.

Still, there's a real difference between Training and Education. Think of the difference if your kid comes home from school and says, "We had Sex Education Class today," as compared to "We had Sex Training Class today." *Vive la différence!*

All for now. / Comments invited!
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BOB'S MAILBOX



Dear Bob:

Although I have spent my adult engineering life with frequencies well above the audio range, I always had great interest in the magic of good audio reproduction....

Where am I going with this? I have a friend who is in the speaker business. He is not an engineer but a musician. His method for designing crossover networks for his speakers was an unbelievable empirical method.

I offered, as a first-class circuits engineer, to design his crossover circuits. What I considered a simple problem turned out to be difficult for many reasons. There is a mechanical resonance at the low-frequency band of the speaker, but this is usually not a problem. One of the most critical problems, though, is that the loudspeakers are not resistive loads—they have a simple equivalent circuit of a series resistor and inductor. The speaker efficiency is usually so low that the acoustic contributions can be ignored. The problem I saw was that the common crossover networks assumed the speakers were resistive. There also was the magic “linear-phase design” that made the problem even more difficult.

After many false starts, I was able to come up with a crossover design that, although complex, took into account the speakers’ efficiency, frequency range, impedance, and a few other minor problems. I modified one of my friends’ standard speakers with the new and improved network, and much to my surprise, the frequency response was flatter than the original. I could not see the crossover points in the frequency-response curve.

Now came the A-B test—old speaker vs. new and improved speaker. My friend listened to his standard selection of CD classical music, then looked at me and said, “No good.” “No good?” I said. “What do you hear?”

After some work he found a passage in the music with just cellos and violins. The cellos and violins alternated

every few seconds, and with the old crossover design even I, with no musical talent, could tell the difference. But with the new and improved design, I could not tell which was which. I still don’t know why, but I am still working on the problem.

JACK KOZOUJIAN
Matrix Test Equipment Inc.
Middlesex, N.J.

There are many ways we can fool ourselves with “well-engineered” systems that our ears do not like. What if you set up a storage scope to “trigger” at a certain point, and record the audio with both crossover systems. Would a microphone show any different pictures? If you listen to a sweep offrequency, they sound the same, eh? So, it must be the transients.... dogone, it’s always the transients. Let me know how this works out, and what you learn.—RAP

Dear Mr. Pease:

Are you guilty of “throwing out the baby with the bath water” in your May 13 article on Speaker Cables? You said, “Note, Mr. Kaye thought I should subscribe to *Audio Amateur*, or *Glass Audio*, or *Stereophile*. I’d rather spend my money on a subscription to *Sound & Vision*.” ...However, in your reply to Mr. Kaye, you seemed to lump all of his suggested reading into the same category. If this is the case, I urge you to reconsider your sweeping generalization.

Audio Amateur is NOT a subjectivist magazine which leans toward the kinds of unsubstantiated faulty science of Mr. Kaye. *Audio Amateur* and the other publications of *Audio Amateur Publications*—*Glass Audio* and *Speaker Builder*—are excellent magazines aimed at a more technical audience than *Stereophile* or *Stereo Review*. *Audio Amateur Publications* prints articles on audio theory and practice from known technical experts, and from amateurs. They contain construction projects, tutorials on specific audio-related engineering topics, and articles describing objec-

tive listening tests and objective measurements. You will even find articles from National Semiconductor employees in these publications.

Speaker Builder also published an excellent objective comparison of speaker cables showing the results of measurements at dc, across the audio spectrum, and at very high frequencies. This article did a better job debunking the myths of exotic cables than your recent column.

If you are not already familiar with these publications, I encourage you to check them out and draw your own conclusions.

BOB NIEDORFF
Unitrode Corp.
Merrimack, N.H.

*That George Kaye tricked me! He got me to say that if HE liked something, I wouldn’t. I have never heard of *Speaker Builder*, but I have no objection to a magazine on this. Maybe some experts who read, or write for, *Speaker Builder* would like to comment on Mr. Kouzoujian’s problem. As for the other magazines, I’ve always found *Glass Audio* very introverted. Everybody to their own tastes. I have not run into *Audio Amateur*, so I’ll try to look it up. But, I still prefer to spend my money on *Sound & Vision* or *The Audio Critic*.—RAP*

Dear Bob:

A few years ago, I moved to Europe and found myself living in a house with dawn-of-the-century power wiring. Everything worked fine except one circuit with light and power points that worked intermittently. There was no obvious cause, and I was told it must be “overloaded.” Strange thing was, you could switch on a light and sometimes it would come on normally, while at other times it would start slowly after a variable delay of a few seconds.

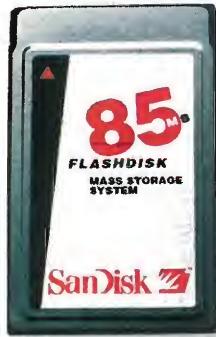
I managed to ignore this for a while until one day a small motor was plugged into the same circuit, and it also started “slowly,” taking about 10 seconds to run up to full speed. This soft start was too much to ignore, so I

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READER SERVICE 171

PEASE PORRIDGE

started working back down the power line looking for some explanation.

Back at the main power board there was an impressive collection of copper bus-bars, and some very old-fashioned fuse holders. A meter showed some voltage drop at the junctions of the copper bars, and a large black body of corrosion could be seen between the bars. This junction became hot when a load was connected to the circuit.

The black material between the copper bars was apparently a natural semiconductor, possibly copper oxide or sulphide, with high resistance when cold and low resistance when hot. Applying a load caused enough current to flow to start the warming process, with eventual thermal runaway and a "soft" start for the connected lamp or motor. Of course, the time delay depended on the ambient temperature of the junction when the load was first connected. And once it was up to "working" temperature, everything operated normally.

I seemed to be the only person around that thought this was remarkable, but I guess I won't get a patent on it because the copper-oxide semiconductor has already been discovered. Apart from roof gutters with bad joints that intermodulate strong RF signals, I can't think of another example of a natural semiconductor that can be observed "by accident." Can you?

G. ROLAND BRADBURY
COPYGUARD Electronic GmbH
Geisenheim, Germany

Haven't you ever heard about the woman who began "hearing voices?" When she talked to a psychiatrist, she realized she also was hearing music, weather, and news. The fillings in her teeth were rectifying some local strong radio signals. Similar cases occurred with old, half-rusty bedsprings acting as receivers. Is a bedspring or a silver-amalgam filling any more "natural" than a copper bus-bar?—RAP

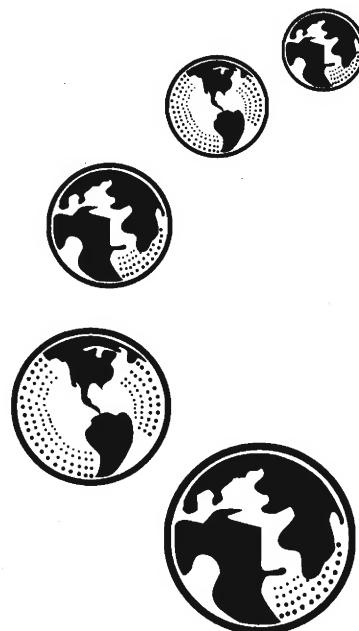
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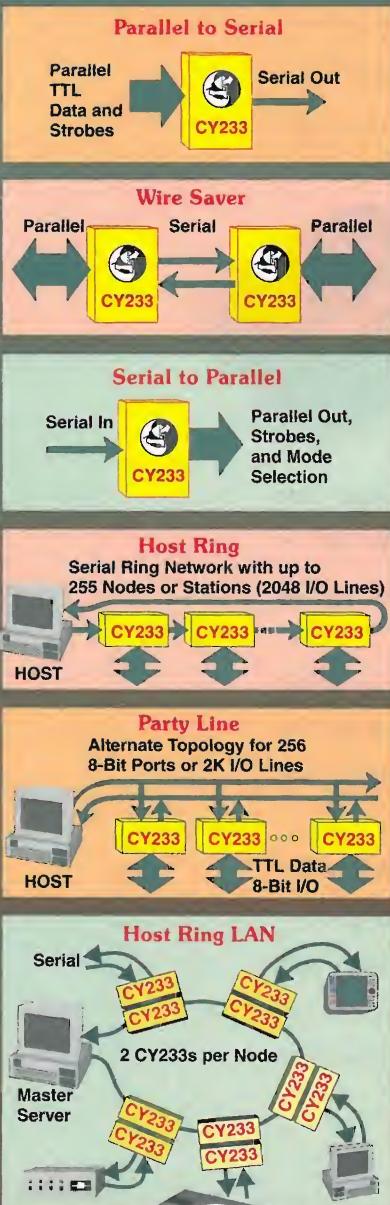
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READER SERVICE 91

EDITORIAL

MILESTONES

It's a good guess that most of *Electronic Design*'s readers are familiar with Bob Pease and his "Pease Porridge" column. Thanks to the power of the mass media and the willingness of *Electronic Design* to serve as a lightning rod on controversial issues, Bob has become something of a legend in the global engineering community. Known among his engineering brethren as "The Czar of Bandgaps," Bob also has earned a few considerably less exalted sobriquets from the magazine's staffers—but we love and respect him nonetheless.

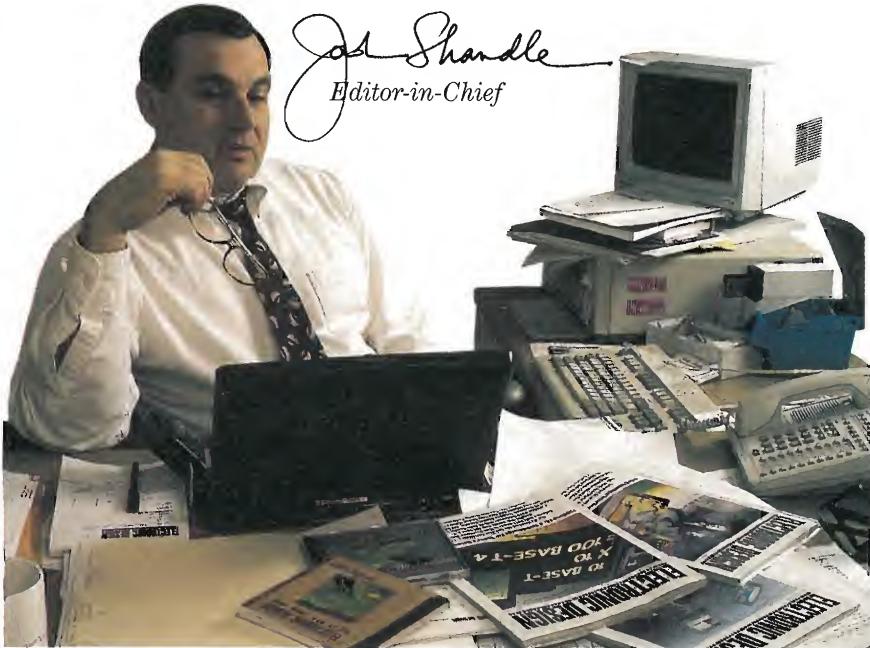
The big news is that we are publishing Bob's 100th column in this issue; a milestone worth noting. Over the past few years, we have served as Bob's global soapbox for well-reasoned rants on many topics of technical and not-so-technical interest including fuzzy logic, the Taguchi method, audio cables, and even diabetes. Even if you don't agree with him, his views are so clearly and unequivocally stated that they gain your respect.

Anyone who circulates in the EE community, particularly in the Silicon Valley, hears plenty of Pease stories. My favorite involving this magazine happened earlier this year when *Electronic Design* held a dinner honoring two long-time employees, Digital IC Editor Dave Bursky and Analog Editor Frank Goodenough. Bob is famous for his jokes, but we were doubly favored because he played one on us in absentia. I had asked Bob to deliver a testimonial for Frank Goodenough (who, by the way, recruited Bob to the magazine).

Unfortunately, Bob had a previous engagement, but he promised to send a marketing person in his place. I didn't think any more of it until the evening of the event when a team showed up with Bob's famous balance-beam demonstration. (The idea is to get a ball bearing to balance in the middle of the beam.) Needless to say, the demonstration floundered. Or so it seemed, until Bob's stand-in proudly announced: "Fuzzy Logic."

As we congratulate Bob for his 100th column, we are planning another milestone next month when Peter Cochrane becomes a regular columnist. Peter is the director of Advanced Applications and Technologies at British Telecom Labs in the U.K. Unlike Pease, Peter has 4000 engineers working for him. Like Pease, Peter has a burning desire to disrobe the bureaucracy. When he was promoted to his present post, Peter said he would not respond to paper communications. Only e-mail, he insisted, because it makes for less BS. The bureaucracy resisted. Peter persisted—and won. I hope you enjoy his columns. *jshandle@class.org*

J. Shandle
Editor-in-Chief



PEASE PORRIDGE

WHAT'S ALL THIS "MOTHER, MAY I?" STUFF, ANYHOW?

No, this is not another "Bob's Mailbox" column. But for reasons that will become obvious, this is a letter I just *had* to write. And I did so—on June 7, 1996:

XYZ Photo Lab
14 Berry Street
Hayward, CA
Attention: Marie, Customer Service Manager

Dear Ms. Marie,

I went down to National Semiconductor's Company Store on June 4 and turned in 10 envelopes of 35mm Negatives to get large color prints made. Specifically, I wanted to get 25 large prints, 8 in. x 12 in. each.

I came down to the Store on Friday, really expecting the prints to be ready. But the Store Manager said, "No, there must be some kind of problem, because there are no large prints, just the negatives, with some kind of message inside."

I opened the envelope and found this note:

"Dear Customer: Your order is being returned incomplete because of the following cost verification: The total for 25 8x12s is \$77.25.

"If this amount is agreeable, please sign in the space below and

return your order with this letter to Customer Service to assure proper handling."

Then as a final insult, the note apologized: "We regret if this has caused you any inconvenience... Sincerely, Marie, Customer Service Manager."

I asked the Store Manager if she had ever seen anything as silly as this before. She said she had not. I asked her if she had ever seen this form letter before. She said she had not, in her 12 years at the store. I said I had brought in orders for \$100 of photofinishing before and nobody ever delayed my work, or questioned whether I could afford it, or whether I really wanted what I said I wanted. She said she often sees people bringing in orders over \$100, and nobody ever questions the order.

So, first, I signed the stupid letter: "YES, please do make all 25 Big Prints as requested," and I turned in the form letter.

Then I decided to try to find out what is going on. That is what this letter is about.

FIRST of all, Marie, you did NOT have to send me a form letter. I put my phone number on the order envelope. You could have called me and I would have instantly approved the order. That would have saved a lot of time.

SECOND, even if you did have to write me a letter, you did not have to send the negatives back with the form letter. You could have held onto the negatives, and as soon as I got the letter, I could have phoned you to go ahead—on Thursday. But no, by sending the negatives back, you could not start this work on Friday—you had to wait until the negatives got picked up on Monday. That is ANOTHER unfor-

tunate waste of time.

THIRDLY, YES, this HAS caused me some inconvenience. I was hoping to show these prints to some friends on Thursday and Friday and Sunday. Obviously, since you did not have the prints ready on Thursday or Friday, I could not do that. Your poster in NSC's Company Store says that one can get one-day service on big prints from 35mm slides. If this is not true, you should not promise it.

BUT the real problem seems to be your policy of asking a customer to say "Yes--I--REALLY--WANT--what--I--said--I--wanted. Yes--Mother--May--I--Please--Have--What--I--Want." We are having too many cases here at work where we have to DOUBLE-CONFIRM that we really want what we say we want, and it is getting silly. I am working on my work problems as a separate matter.

In YOUR CASE, I have to ask, "WHAT IS YOUR POLICY?" If you decide to ask any time the order is over \$1000 or over \$500, or over \$200, or if it looks like a typo error, or if you cannot read what was requested, then I can see that you have to protect yourself from the possibility of doing unwanted work. If you can't be sure I want 3 prints or 30 prints, it's reasonable for you to ask. I am a businessman, and I understand that.

BUT NOTE: You did not ask, "I am not sure I can read what you wrote." Your form letter said: "cost verification."

The poster at our Company Store plainly says \$3.09 for 8 in. x 12 in. prints. If the price were to change, I would complain that you changed the price but did not change the posted, advertised price. But I would still pay the price of the order. Of course, I still have to pay tax on top of that, even though much of the \$77.25 is for service and labor that ought not to be considered taxable, and not for materials that ARE taxable.

So it boils down to this: "Can the customer afford to pay \$77?" I can assure you that I can afford to pay \$77, and the \$0.25, too, quite easily, PLUS the tax on top of that. In fact, it's already obvious that I paid a great deal more than \$77 to get those



BOB PEASE

OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

PLEASE PORRIDGE

10 rolls of film developed and printed in the small size. In fact, I could probably afford to buy your whole plant, and fire any or all of the company's employees, including you. So I am amused that you ask, "Can the customer afford to pay \$77?"

Now, you MIGHT be asking, "If I make you \$77 worth of prints, will you stiff me and refuse to pay?" Well, if I didn't pay, you could hold my negatives, and those are a LOT more dear to me than a mere \$77.

I could also observe that I just came back from Kathmandu, Nepal, where the average wage for a whole month is about \$77. And I never had any problems or hassles getting photofinishing done there.

So, I just want to know—what is your policy? At what point do you decide to question an order for "cost verification?" What makes you decide? If I sent in 4 separate envelopes for \$30 each, you would not ask for "cost verification?" But if I put it in one envelope you would? If I asked for 20 or 30 copies of ONE PRINT, would you raise a FLAG? If so, why? Is your computer programmed to question whether your customer will be permitted to do business?

Marie, I shall be happy to talk with you and your supervisor to find out what is your way of doing business. That's because I NEVER have seen such a poor way of doing photofinishing business as you did.

I admit, when I brought in my film on Tuesday afternoon, I knew they wouldn't be back on Wednesday. But I did hope they would be ready by Thursday. And at least they would be ready by Friday. Now I gotta wait until they are picked up on Monday, and with some luck they will be ready on Wednesday. THAT is SLOW SERVICE. There are MANY ways you could have done it faster, and I hope in the future you will learn to be more efficient. I mean, I am a businessman, and I do like to do business in an efficient and business-like way.

For example, if at a certain \$\$\$ level of order—such as \$200—we should provide, in advance, along with the order, a statement that we DO know

what the bill will be, and we DO want to pay this. Then we will sign off on this form—in advance—so as to avoid delays. I mean, I KNEW the cost of my order would be around \$85, including tax, and I KNEW I could pay for this with plastic or a check or cash, which ever was most convenient at the time. I just did not imagine anybody asking, "Do you really want to pay for these prints?" Or, "Are you able to pay for these prints?"

Yours truly,
Robert A. Pease / Engineer

Just as I was typing this, I hit Alt F7 F9, which means, "Delete All Page Breaks." The computer responded by saying, "Do you really want to remove All Page Breaks? Press F9 again." So I did.

Sometimes when I go to the bank, I put some checks in the ATM, then enter the amount, and then hit OK, and the stupid machine displays a request, "Are you SURE that you REALLY want to deposit \$2123.28?" And I have to hit OK a second time.

Sometimes at work, I want to get Permission to Write on a certain computer file. I type a note requesting Write Permission, and I send it to our System Administrator. In an hour or two or three, I get a message telling me that I do have Write Permission. And then when I log on to that file, sometimes I get the message that I do NOT have Write Permission. I am still working on this.

A while back, we got a new, improved "CallUp" system for our computers. I can list all my personal work information, such as my name, phone, fax number, e-mail, office location and Post Number, etc., and then any employee can call up my name and get any information they want. However, this system has a few little enhancements. I can go in and change SOMEBODY ELSE'S information.

For example, if there's a guy who is having trouble putting in his info, I can do it for him. Then he will get a message saying that I was helpful and changed the information for him. This worked pretty well until one guy got curious and decided to go in to Gil Amelio's CallUp file, and he modified it to say some strange

things! At that time, he did not know that a report would be issued to Gil stating exactly who had made what changes. Obviously, the poor guy was embarrassed. But, eventually, the guys who gave us this system added one interlock, so if you did not provide blanket permission, nobody else could change your CallUp information. But, at least you did not have to ask permission to change your own data.

Recently, our Payroll Department changed to a wonderful new system, System O. It had a few dozen things wrong with it. It was quite hard to figure out what to do or how to use it. The owners of this system said, "This new system is Very User-Friendly." But it wasn't. The only thing that WASN'T wrong about it was you didn't have to ask permission to use it, just enter a normal password. However, if the system ever crashed, you had to reinsert all of the information, INCLUDING your boss' Employee Number. Then after you inserted his Employee Number, the computer told you that you now had to get permission from another person to proceed.

At that time, everybody's Employee Number was a secret, and nobody was supposed to know what anybody else's Employee Number was. When System O crashed, my boss was out of town, and nobody knew his Number. We could not log on, and our technicians got paid a couple days late. In retrospect, we should have been able to go into CallUp and find his Employee Number—but that wasn't working, either.

There certainly are a lot of places where foolish, mindless systems require us to get special permission to do some little thing, which really is ridiculous and childish. Sometimes these decisions are required in computer systems—and sometimes in systems where people make absurd decisions.

When I take in my car for repair, I have to sign a form on an estimate, such as: "Front brakes, Parts and Labor to re-line, \$160." Fine. I sign that estimate. Then if the estimate changes because the mechanic finds the drums have to be replaced, or if the rear brakes have to be re-lined as well—

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then I have to approve the new estimate. I can do that by phone. At least the guy doesn't have to send me a letter for me to approve the work. But that's fine by me. I'd rather have this than just an automatic go-ahead.

Emmy Denton asked me, "Bob, do you remember the time you erased my whole Hard Disk?" I groaned, yeah. She said, "That would have been a good place to have a 'Mother, May I?' permission." I agreed.

But I am sure that there are MANY other places where foolish "Mother, May I?" procedures waste a lot of our time....

The day after I typed this letter, an engineer at a different company said he begged for a month to get a password. Finally he got it. Then he had to plead to get the procedure to make the password work. When he got it, it did not work. More begging....

Well, I finally got my prints. They were more than a week late, by my reckoning. They sure were nice, though. Now I can stop singing *Yes, someday my "prints" will come*. But, oh yeah, it's been 12 days since I sent in that letter. I had not gotten any reply from Marie or her supervisor, so I called her up. She said that her lab's policy is that any order larger than \$50 requires a signature on a form letter. If I had sent this order in as two separate orders, each for \$40, they would have sailed right through. Or if I had sent in 40 rolls of film (as I sometimes do), each costing \$10, no problem. But if I want 20 copies of the same print, I will have to send a Mother-May-I form, signed in advance, to avoid silly delays... Sigh....

Well, it is about time for me to order some more Big Prints. But before I place my order, I think I will send Marie's supervisor a little form letter, asking him/her to sign it, and acknowledge my gripes, before I permit THEM to do business with ME....

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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PLEASE PORRIDGE



BOB'S MAILBOX

Dear Bob:

I don't usually react too much to your column other than to enjoy it, but your "Speaker Cable Stuff" for May 13 really hit a nerve. For many years I have read the papers on these lunatic fringe hi-fi audio theories and put as much credence in them as in UFOs. Come to think of it, there are UFOs, they're just unidentified.

In the 60s, I read an article that claimed that if your stereo preamp wasn't flat from dc to 50 MHz (with an M), then you would hear unacceptable "transient intermodulation distortion."

But back to the speaker cables! If they are 20 feet long and the wrong impedance, they are also 20 ns long and might ring at 25 MHz. Big deal! But, of course, if you have some of George Kaye's "solder oxide" junction diodes, they would likely rectify the 25 MHz and create havoc. I can't see how the cable reactance could possibly affect anything. But the resistance is another story if the speakers are 1-2-4 ohms as Kaye implies, and those fancy cables are humongous. Trying to put 800 W into your \$3 lamp cord may hurt your dynamic range; you may only get 700-W peaks and, perhaps, George Kaye can hear that difference.

Now, if you invest in two lamp cords (we're up to \$6 now) and Kelvin-connect the speakers to the Amp Out and the Feedback, want to make any guesses as to the result? The amplifier is now tracking the speaker cone instead of the zip cords. Time to melt down those silver wires. Oxygen-free hard copper may have lower resistivity than copperus commonus, but I prefer the Kelvin solution.

Does it ever occur to anyone that the weak links in the system are the electromechanical transducers at each end. I have never seen distortion figures for microphones or speakers that come close to the levels achieved by electronics. For the average Joe who doesn't own a pair of exponential horns, the tiny shoebox speakers are common, but they have to be non-

linear because of pressure buildup in the sealed box. To overcome the cutoff frequency of the speaker cone and get some bass out of your 4-in. sub contra bass woofers, the designers pack them into a small box and kill the mid-range response until it matches the terrible bass response to achieve flatness. This is why we need these megawatt amplifiers.

I used to have a Goodmans AXIOM 80 speaker with a 17.5-kilogauss magnet and a 20-Hz fundamental resonant frequency in a 2.5-cubic-ft.-reflex box with an acoustic resistance load. It took only 4 good watts to level my living-room walls.

As for the valve amplifiers, I know they put out a warmer sound because I used to burn my hands on them. Because so much depends on what happens to the power supply and amplifier bias under overload conditions, any sound difference between tubes and transistors can hardly be ascribed to tubes.

Mr. Kaye doesn't like a 10-kHz waveform with only 4 samples, but that is well above the top note on an organ with a 2-ft. stop, let alone the normal 8-ft. stop. The first overtone is at 20 kHz, and very few people can hear that even by itself, let alone with all the other music. With 4 samples, even the harmonic can be reproduced faithfully.

Remember how all hi-fi preamps used to have a 47-k Ω input resistor for the magnetic cartridge? Designers used negative voltage feedback to make their transistor-amp input impedance extremely high like a tube, and then used a 47-k Ω resistor across the input. I never could see the sense in burning up the transducer power in a resistor and then trying to amplify the dregs at low noise. Seems to me you would make the transistor's base look like 47 k Ω by design, and then stuff *all* the signal power into the transistor instead of wasting it. We had a simple design for such a beast at Tektronix in the early 60s, and we

never had any audible preamp noise. We even used the cartridge inductance to make one of the RIAA corners.

By the way, my interest in audio and music is entirely in the way it sounds, not in what a spec sheet says, and my expectation standards are extreme. But unfortunately for most of us, the available software (recordings) are rather pitiful.

My LPs all have two defects: they are never flat, and some do it always bores the hole off center. I expect that CDs have overcome these problems, but finding well-done, digitally-mastered recordings of quality performances of interesting music is a tough chore. There still is not a digital recording of "The Ring of the Nibelung" that can hold a candle to the Decca/Solti analog recording from the early 60s.

The real contribution made by the audio engineering fraternity is to provide some very good sound for the average person in his studio apartment at a reasonable price. The trouble with performances on high-end audio gear is that they are usually in public environments and are always marred by coughing, talking, chocolate wrappers, and fire sirens, just like live performances. Wanna split those \$900 wires—excuse me—cables with me Bob?

GEORGE E. SMITH

Engineer/Scientist

Hewlett-Packard Co.

Optical Components Div.

San Jose, Calif.

I'm sure that there are many audible differences in speakers; everybody to his own tastes. I'm sure that the new, improved speakers that critics raved about, 10 or 20 years ago, now are considered dreadful. My old speakers, on the other hand, sound just fine.

The concept of Kelvin connections causing the power amplifier to force the true response at the speaker sounds very appealing, but it also sounds scary because adding the inductance and delay inside the loop might make the loop very hard to sta-

PEASE PORRIDGE

bilize. However, if you used a low-Z 8- Ω cable to drive an 8- Ω speaker, there is zero effective inductance and not much delay. Therefore the loop closure may not be so difficult. Still, isn't it much easier to bring the power amplifiers over by the speakers? Or just use low-Z wires? After all, can anybody hear the difference?—RAP

Dear Bob:

....I bought an "Easy" development kit consisting of 436 files in 416 Mbytes—and it had hardly any documentation. After four weeks I still don't know how to start to use it. But I learned how to change the color of the frames, the font of the letters, and how to change the icon from a garbage can to a geranium. A skunk would be more appropriate.

I was looking for a PLL-clock-generator chip to generate the number to be loaded into three programmable counters. They supply you with 12 programs in 1.1 Mbytes.

The best text editor I ever used was 48 kbytes. It did the same job better—and much more—than the one which is 1000 times larger today.

In spite of the man-centuries of development, I still would like to see a software package without a bug. But at least they now come in a variety of colors and shapes. Well, this is progress, or is it?

NICK BUCSKA
PC Peripherals Inc.
Broomfield, Colo.

Nick—my Word Processor uses just 75 kbytes, and it's great (PC Write Lite). I, too, am horrified by the gross excesses of "modern computing," and all their mind-boggling multimedia, and multicolored bugs.... As Yogi Berra said—"Progress may have been alright once, but it just went on too long...." Myself, I am usually NOT required to junk my OLD computers and software.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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READER SERVICE 109

WHAT'S ALL THIS MEASUREMENT STUFF, ANYHOW?

Our town newspaper, the *San Francisco Chronicle*, has a Trivia column that runs twice a week. Recently, a couple items caught my eye: "If you have 9 pennies and your scales say they weigh an ounce, then you know your scales are in calibration." I reached in my change bucket and grabbed 9 pennies and put them on my gram scales. It came out to 26.1 grams—*rather* less than 28.35 grams—definitely less than 1 ounce. Hmm. What is going on? Surely the Trivia Man has to be correct. One penny has to weigh as much as the other, doesn't it?



BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

kinds of pennies weigh what. One time I got some pennies with glue on them. I put them on my stove burner and burned the glue off. No problem. Note, the amount of electricity it took—perhaps $1\text{ kW} \times 60\text{ seconds}$ —is less than the cost of the pennies, by a factor of perhaps 10.

Then, months later, I got some more pennies with glue on them. When I put them on the stove, the pennies began to droop and melt. What the hey? Somebody is making counterfeit pennies? I complained to the Secret Service that somebody seems to be counterfeiting pennies. It was only LATER that I realized that the U.S. Government is making counterfeit pennies. Zinc instead of copper. No wonder that some melt (the new ones), while the older copper ones do not. I'd forgotten about that, until the weight of the pennies reminded me.

The Trivia column then said, "How thick is a millimeter? It's as thick as your thumbnail." Hmm. My thumbnail was a little too long—and it needed to be trimmed. So I trimmed it off. I looked at it. It surely did not seem to be nearly 1 mm thick. But I didn't have any precision calipers or micrometers. So how could I tell how thick it really was?

I took a small steel ruler, about 1/4 inch wide, and stood it on end. I used the ruler to make a differential measurement between the thickness of the thumbnail and the thickness of several sheets of ordinary copier paper. This was done by standing up the ruler with one corner on the thumbnail and one corner on the paper stack.

NOW, we know that a stack of 5 reams (2500 sheets) of paper is 9 inches high. I have lots of old Xerox boxes exactly that high. So we know that 36 inches of paper equals 10,000 pieces of paper. Each sheet is 3.6 milli-inches thick—give or take 5%.

When I compared the thickness of the thumbnail to 3 pieces of paper, the ruler stood up with a tilt to the left. When I compared it to 5 pieces of paper, it tilted to the right. When I compared to 4 sheets—neutral. Of

course, I had to turn around the ruler to make sure it had no bias. And I swapped around the base to make sure it had no bias. In conclusion, my thumbnail is about 14 milli-inches thick, or 0.55 mm. Not 1.0 mm. I sent a note on this to the Trivia expert, stating that he was wrong by nearly a factor of two. No reply yet.

Then Mr. Trivia said, "What is there that weighs a gram? One paper clip." I got suspicious immediately. I grabbed a collection of paper clips and put some on my old Cenco Triple Beam Balance—scales that can measure up to 111 grams, with a resolution of 0.01 grams. The small paper clips all weighed 0.5 grams. The big ones all weighed 1.5 grams. I never did find one that weighed 1 gram. So Mr. Trivia does not have a very good batting average with me....

My point is NOT that you need fancy scales or meters to make a pretty good measurement. You need *thinking* to make pretty good measurements. A good scale or meter just makes it *easier*.

Back in the 1960s, some guys could not make any measurement without a precision differential voltmeter—a Fluke meter. Remember those knobs that you had to servo by hand to match the unknown voltage? When a guy could not make a measurement without one, we called that "Flukemia." But then digital voltmeters came along. Now we have a whole generation of engineers and technicians that only know how to measure things with a DVM. That is a far cry from engineers who know how to prove that 9 pennies weigh 1 ounce, under difficult conditions....

That reminds me of a lecture I once gave—"What's all this Measurement Stuff?"—to a local group of engineering students, sponsored by the IEEE Measurement Society. I asked these students, "What are the biggest sources of error in measurements? Thermocouples? RFI? Bad connectors? Non-infinite input impedance?" I left the slide up on the screen for several extra seconds.

The next slide listed: "Ignorance... Apathy... Carelessness... Sloppiness... Stupidity..." This always draws chuckles. But it is partly true—when one is measuring things, the INSTRUMENTS usually aren't a source

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of error. It is our foolishness in misapplying them that causes errors.

One time I was evaluating an expensive DVM. About £4000 worth. This was a nice DVM that not only had high guaranteed accuracy, but it had a display that would tell you how accurate it was. For example, on a 1-megohm scale, it told us that its accuracy was guaranteed less than 0.01% when measuring 1 megohm.

I slapped on one of our lab's 1-meg resistors—a precision wirewound resistor. The reading was 999,800 ohms. Hmm. Now, it's uncommon to find a 1-megohm wirewound resistor that has drifted that much (-200 ppm). When I go down to Haltek and buy old wirewound resistors, I like to buy old ones because a resistor that's 5 or 10 years old, and still in spec, is at least as good as a brand-new resistor because it has some proven long-term stability.

I slapped this 1-meg resistor onto our HP 3456 DVM. It read 1,000,005 ohms. But we had to admit that the HP3456 is only specified to an accuracy of 0.02% on that scale. Maybe the HP was wrong?

I decided to use jiu-jitsu to prove which DVM was telling the truth. I had some new 100 kΩ wirewounds that were specified at 0.002%. I measured 10 of these. BOTH DVMs agreed that these resistors were all nearly perfect, ±5 ppm. Then I clipped the 10 resistors in series. The HP said 1,000,000 ohms. And the expensive English DVM said 999,800 ohms. Yet it swore that its own accuracy was no worse than 0.01%. Well, we sent in a nice calibration report when we gave that DVM back to its sales guy. We never did hear any explanation or apology from him.

So whenever I measure things, I like to do some little self-calibration test, just as a sanity check. I like to measure some things whose accuracy I think I know. Like the capacitance from the earth to the moon....

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:
Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

PEASE PORRIDGE

P.S. I received a lot of answers after asking the question, "What is the actual capacitance from the earth to the moon?" There were a few odd ones at 0.8 μF or 12 μF. But about 10 guys said it was 143 or 144 μF. They used the formula:

$$C = 4\pi\epsilon(1/r_1 + 1/r_2 - 2/D)^{-1}$$

valid for $r_1, r_2 \ll D$

NOW, my original estimate of 120 μF was based on this approximation: The capacitance from the earth to an (imaginary) metal sphere surrounding it, 190,000 miles away, would be 731 μF. (If that surrounding sphere were pushed out to 1,900,000 miles away, the capacitance would only change to 717 μF—just a couple percent less. If the "sphere" moved to infinity, the C would only decrease to 716 μF.) Similarly, the C from the moon to a surrounding sphere 48,000 miles away would be 182.8 μF. If the two spheres shorted together, the capacitance would be 146.2 μF. I guessed that if the spheres went away, the capacitance would drop by perhaps 20% to about 120 μF, so I gave that as my estimate. But removing those conceptual "surrounding spheres" would probably only cause a 2% decrease of capacitance. That would put it in close agreement with those 10 guys that sent in the 143 μF figure.

But THEN 6 readers wrote in LATER—from Europe—all with answers of 3 μF. I checked their formulae, from similar books, in several different languages. They were all of the form:

$$C = 4\pi\epsilon(r_1 \times r_2)/D$$

multiplied by a correction factor very close to 1.0. If you believe this formula, you'll believe that the capacitance would be cut by a factor of 10 if the distance D between the earth and moon increased by a factor of 10. Not so! Anybody who used a formula like that, to arrive at 3 μF, should MARK that formula with a big X.

Finally, one guy sent in an answer of 159 μF. Why? Because he entered the correct radius for the moon, 1080 miles rather than 1000. That's the best, correct answer!/RAP

PEASE PORRIDGE



BOB'S MAILBOX

Dear Bob:

About hollerin'... I enjoyed your article about hollerin' in the June 10 issue. I agreed totally with your opinions, right up until you said "Ideally, we shouldn't have to holler at anybody."

Well, first, it's obvious that God made our lungs and larynx so that we can holler, ergo it must be something we're supposed to do. No, I happen to believe that hollerin' is a useful tool, not just something to do when you bash your thumb with a hammer. A few specific cases illustrate this point.

Back in high school I earned my keep one summer teaching in a reading skill improvement program for dyslexic students. We took these pupils, guys Montessori wouldn't touch, and in about eight weeks raised their reading level an AVERAGE of 2.5 grade levels. The technique, developed by Dr. Charles Shedd, involved simultaneous stimulus of most of the human senses during a learning session. We had 50 instructors with 50 students in a school lunchroom all hollerin' "See Spot run!" at the top of our lungs for six hours every day. The aforementioned results speak for themselves. I also found, after a few days, that all that hollerin' didn't bother my concentration one bit. Perhaps I'm a little bit dyslexic, too.

Next case in point is far more recent. I enjoy coaching youth football every fall. As you might suspect, football involves a lot of hollerin', and I tell my parents so right up front. Last year I had a mother come to my wife after one or two practices saying that her son was upset that I was hollerin' at him. "What did he say to your son?", she asked. The mother answered with a big grin, "He yelled, 'Good job!'" That kid has developed into one of my finest linemen, and he hollers encouragement to his teammates. Sometimes when I holler at him, he hollers back. Now we're getting somewhere.

I used to be the kind that held everything in. This resulted in busted telephone handsets and chairs thrown

through walls at work. More recently, I have started practicing some hollerin' concepts outside the confines of the football field. My co-workers and management seem more satisfied with this approach. My wife is not so sure. Anyway, I think that since you seem to be more advanced than others of us in this area, you should author a guide book, perhaps entitled *The Art of Hollerin'*. Topics for the novice workplace hollerer could include when to Holler at the phone, when to Holler INTO the phone, Whether to Cuss or just Holler, and how to be Hollered At. Having decided that hollerin' makes me a more well-rounded individual, it is these finer points that need attention!

JAMES A. MCKENZIE
Principal Member I
Ford Microelectronics

WELL, I wonder who figured out that HOLLERING is good for curing dyslexia. It is WELL KNOWN that hollering works well on football players. Maybe it was found to work on a dyslexic left guard?? "See Spot run to daylight..." I'll let YOU write the HOLLERING guidebook.—RAP

Robert:

Haven't felt the urge to write for some time but your comments about hard drives, floppies, etc., in June 24 issue tweaked some strings with me.

The first laptop I owned was a Tandy Model 100 with 32 k of battery-supported static RAM, no floppies, and a little audio-cassette machine for mass storage. Cost me \$300 on sale. Carried the critter everywhere and used it a lot! Got a burr under my saddle one day and bought a two-floppy, DOS machine. Now I was REALLY moving up... except the battery life was only about three hours and it took 14 hours to recharge. Further, the battery was internal. But the screen WAS larger and backlit so... what's a little hassle about battery life?

About a year later I saw a laptop

with 20-Meg hard drive and removable batteries on sale. Wow! Just what I needed! Unfortunately, battery life wasn't much better. It took six batteries for a round-trip to the East coast. Further, the thing wouldn't fit in my briefcase, and it cost 2 kilobucks... worried about the durn thing a lot in airports.

Another year later, I stumbled onto a special interest group for the Model 100 Tandy machines on Compuserve and was reminded of what I once had: More RAM than I could fill on one trip, eight hours of battery life on AA cells available from any airport gift shop, fits inside my briefcase, and here's the best part—bought two of them off of Compuserve for \$100 apiece. Carry one every trip and get lots of writing done. A serial cable lets me dump contents to the desktop machine when I get home for finishing work. Keyboard is full-sized, key action is good, and the screen is 8 by 40 with really fat characters so I can work without my "cheaters." If I drop one on its head, I'm only out \$100 and the time it took to fill less than 32 k of RAM. I'm computer-poor with byte-thrashing desktops but when I travel, my favorite NO-FLOPPY machine goes along. Took it to Portland last week and wrote two articles. There's a not-so-old saying I've been sharing for several years now, "Try as one might, it's difficult to make much of an improvement upon the hammer."

ROBERT L. NUCKOLLS III
Consulting Engineer
Wichita, Kansas

Well, if modern technology were applied to a Tandy 100, it would sure have some nice advantages. The whole idea that a laptop has to be ready to spring into action at 100 MHz while you sit there typing away at 0.000003 MHz sure seems bizarre to me. Not to mention those power-hungry color displays... Maybe you can tell me where I can buy one of those old Tandy 100s...? I went by a Radio Shack yesterday, but the Model 100 is discontinued. Sigh.—RAP

PEASE PORRIDGE

Dear Bob:

In your May 1 column in *Electronic Design*, you said in part: "Modern etched circuit boards...really do improve uniformity of performance, and reliability, too. I mean, old hand-wired Tek scopes were not terrible, but nobody would want to do without the advantage of modern wave-soldered circuit boards."

You denigrated Tek, (and indirectly Zenith, since the reader referred to them.) Those two companies were to me the paragons of beautiful design and construction when I was first learning.

We have had several hand-wired Tek scopes, and even after 30 years (yes, we have 30-year-old Teks we still use occasionally), I never have seen any problems with bad solder joints. (The same goes for the old Zenith TV sets.)

In contrast, I've got a modern 26-in. stereo TV in our bedroom that I got for free—all I had to do was fix it. The problem? A bad solder joint on the circuit board at a main power-supply choke. Same thing for a modern color TV at our vacation shack. A sudden craziness in the green gun action fixed by resoldering.

I see a lot of problems with wave-soldered boards. Often, with smaller boards, a brute-force technique of "resolder everything" will do wonders for an intermittent.

In the 50s, Mad-Man Muntz could sell TVs for half of what Zenith was charging, because he designed them cheaply and built them cheaply. TV repair shops loved Muntz, he provided a lot of work for them.

Wave-soldering has done wonders for the COST of electronic equipment, but dependability is mostly a factor of quality of design and construction. Today the names are different, but there are still the Zeniths and the Muntzs.

You missed that one Bob!

FRANK R. BORGER, Physicist
Department of Radiation Therapy
Chicago, Ill.

There have been (fairly) reliable circuits in the past, and there are reliable ones now. But I'd hate to think of a Pentium PC with hand-wiring! It might not be impossible, but it sure wouldn't be cost-effective. And I'd hate to have to troubleshoot the ones

that didn't work! NOW, the reliability and integrity of the wiring is just PART of the system's reliability. You need to buy reliable parts, and the system must be engineered to avoid stupid misapplications. Building good, reliable circuits is not trivial—never was.—RAP

Dear Mr. Pease

Regarding "What's All This Caffeine Stuff, Anyhow?" in the Feb. 19 issue, I recall a study on the effects of caffeine as well. It may well be the same as the engineer pointed out. What I recall is not quite the same, though. Yes, the workers on caffeine "felt" that they were being more productive and "felt" more positive, etc. However, metrics of their actual performance showed that they were fooling themselves. The non-caffinated participants actually performed MORE work. They just didn't "feel" like they did.

I cannot recall whether the non-caffinated were being forced through withdrawals during the experiment, but their report of their "feelings" seemed to indicate so. I would like to see a good comparison of habitual caffeine dosers against the caffeine-free, if someone is going to make generalizations of this nature.

Having freed myself from the caffeine tyranny, I can observe the effects that an occasional caffeine burst does for me. (No coffee, please, just that green Mountain morning mist tea, or JOLT! for those late night spec write-ups.) It seems to act very much like refined sugar does. Elevates apparent energy and delays fatigue. For awhile. In an hour or two, I find a slump as deep as the rise was high. Just like the mid-afternoon blood-sugar slump.

Now I believe that I am sleeping better with the same hours—five to six a night—I am less tired during the day, and I "feel" definitely less grumpy. I haven't asked my wife or the kids if they agree with this last point. The changes came only after withdrawals were over. Of course, other stimulants still affect me: tobacco, fluorescent lighting, sugar, freeway driving, rowdy children, panic-stricken purchasing agents, etc...

SAM MULLINS

Project Engineer
Mallinckrodt Sensor Systems
Ann Arbor, Mich.

Some people like a LOT of coffee. Some people like a LITTLE. Others can only take Decaf. Some can't stand any coffee at all. I never said coffee—or caffeine—was GOOD for you.—RAP

Dear Bob:

I greatly enjoyed your column on "High End" audio. I was in an automobile electronics store a while back and saw that the current fad (that's a pun) is to gold-plate everything. Yes, even the battery cable clamps that connect large lead-acid batteries to overpowered car stereo amps were gold-plated. Even the bolts that tightened the clamps were gold-plated.

Aside from the engineering questions of clamping gold surfaces against the battery's lead posts (the potential corrosion issues depending on what's under the gold), and the obvious stupidity of thinking that this will improve the stereo's sound, I think there is a deeper issue of the public's ignorance of science.

When I talked with the teachers and principal at my daughter's elementary school, I was saddened to find a universal lack of interest in science, no coherent science program, and no planning for science curricula other than that the kindergarten teacher had "taken training over the summer."

At the school meeting, a parent asked about the science curriculum and the principal's response lead me to believe that she had not thought about it at all. I immediately wrote a very brief science curriculum outline and faxed it to her, and received no constructive response.

My daughter's school is one of the best in the Seattle public school system, with dedicated teachers and many interesting programs. It simply reflects the lack of public interest in scientific and critical thinking.

Engineers, scientists, designers, and technicians can contribute greatly to our society by getting involved at the elementary-school level to encourage and help teachers (who generally have no scientific training) to build fun

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and interesting science curricula in the public schools, so that future generations will not need to gold-plate their battery cables!

WILL REED

Seattle, Wash.

P.S. We hope to build a science lab at our school next year, and work on developing a fun and interesting science curriculum.

The gold-plating on a car-battery connector may be LITERALLY a good idea, because gold will not corrode. But many High-End Audio guys also do "figurative" gold-plating, and THAT I am very skeptical about. As for your volunteering to help with science in schools, I'll be surprised if you don't run into a lot of back-pressure. The teachers may see this as you ENCROACHING on their jobs—even though they may not have any clue on how to teach science themselves... Good luck.—RAP

Dear Bob:

Leave Equipment On? Yup! Usually. Bob, some leave their electronic stuff on, others shut theirs off. If I needed to heat my home most of the year, I agree with you and would leave mine on—with a screen saver. Here in Phoenix, we seldom need more heat and tend to shut stuff off more. If MIL-HDBK-217 were the gospel, wouldn't components last forever if they were off—even aluminum electrolytics?

Years ago, at GE, the feeling was that turning on a lamp, fluorescent or incandescent, shortened its life by about four hours. I can't prove it, but GE SHOULD know a lot about lamps. In mainframe computer applications, we biased those thousands of lamps so they were just below the threshold of glowing. Paying a technician to change lamps was expensive back then, too. "Experts" say flashing a lamp doesn't hurt it. But I'll bet darn few lamps get all the way back to ambient between flashes.

Does the four-hour rule apply to other stuff? Well...

Do on/off transitions hurt more than hours of being on? That "thunk" when you turn on the TV or whatever is due to HIGH inrush current. If things weren't being mechanically stressed, and things weren't moving

around, why did it go "thunk?" Us electronic guys feel all failures are due to something nonelectronic—most likely mechanical.

Heating and cooling doesn't usually go "thunk," but darn few things expand/contract at the same rate... and when they're rigidly attached to one another? Bonds and welds eventually break inside of semiconductors, capacitors, connectors, and displays. Hermetic seals crack and fail, affecting chips and displays. Metals work hardens, and some of those thousands of solder joints become brittle.

If it's electronic, and gets warm when I turn it on, I leave it that way if I intend to be back within four hours or so. If I wanted the heat, I'd leave it on longer. An exception is CRTs (Cathode Ray Tubes, for you youngsters). These are "tubes" and have a finite life—especially the phosphors.

My wife understands all of this and never turns the damn TV off—even in Phoenix.

MIKE MIDDLETON

Senior Engineer

Wirebenders Inc.

via e-mail

IF MIL-HDBK 217 were true, pigs could fly. The four-hour rule does not apply to light bulbs. An expert explained to me that the wear-out mechanism when a fluorescent bulb is turned on is worth four minutes. A modern incandescent bulb's degradation is around 4 to 40 ms of life every time you turn it on. Not four hours. As for ICs, I have never heard of bonds failing, or hermetic seals cracking in ordinary usage. But power devices with a soft-solder die attach will degrade their thermal impedance as a function of the number of thermal cycles and the temperatures of the cycle. And I have not heard of any particular wear-out cycle for CRTs if the cathodes and the phosphors are rested when not in use.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

WHAT'S ALL THIS COMMON-CENTROID STUFF, ANYHOW?

Once upon a time, we designers of op amps used to locate as many of the critical transistors as we could along the axis of symmetry. We put the input transistors right along the Center Line (CL) of the chip, or on a pc board along the CL of the board. We tried to put the output transistors on the CL, too, down at the far end of the layout. We realized that any heating from the output stage could cause significant, serious input errors. For my discrete layouts, I designed "ISIS Clips" and "Omega Clips" to keep the input transistors at the same temperature (Fig. 1).



BOB PEASE

OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

—
designed some little clips made of soft aluminum, with green paint for insulation all over them, in the shape of S—an ISIS clip. This clip has rotational symmetry.

Conversely, an "Omega Clip" has mirror symmetry, like the Greek letter ω . We made these of the same soft

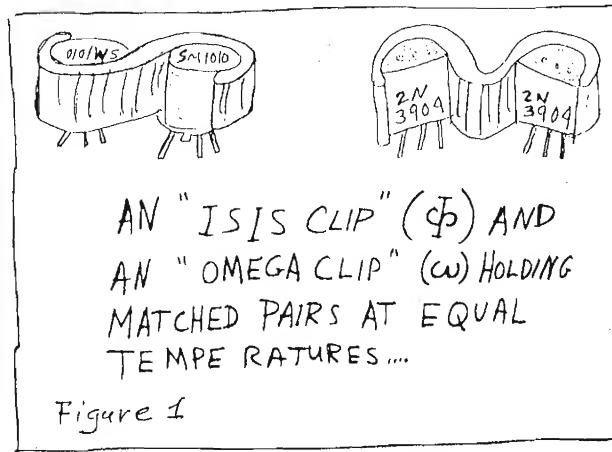


Figure 1

aluminum, and the same green paint. Walter Kern made them up.

When monolithic op amps came along, there were some influences to "keep it simple, stupid." I designed a T52AH—also labelled as Amelco's 809BE—with just 10 transistors, which worked pretty well. But op amps with 20 or 30 transistors soon had just as good a yield. And they offered more features. So, we kept learning how to add more transistors for better performance.

But when the Fairchild μ A714 came along, we designers were really puzzled. Why would anybody use FOUR input transistors? What the heck was George Erdi smoking? If you set up a diff amp with two transistors in parallel at the plus input and two transistors paralleled on the minus input, why would that give an advantage? But the specs showed real superiority—low offset voltages, good bias currents, and low offset current. Hey, this was about 1971. Not many engineers were climbing inside their suppliers' ICs and studying the layouts. If you didn't, though, you could be stuck

with a lousy layout. I know.

The basic feature of the μ A714 was the common-centroid layout of the input transistor "pair" (Fig. 2). If you took those four input transistors and laid them out in an X pattern, it would be denoted by:

AB
BA

Connecting them properly in parallel, you can get the linear gradients of V_{os} to cancel. And the gradients in beta to cancel. Gradients caused by heating from the output stage—and even from other asymmetrical sources of heat—tend to cancel. Any linear gradients caused by imperfect die attach tend to cancel. (Non-linear gradients do NOT get cancelled,

of course, but these are usually small.) And these cancellations all happen thanks to a common-centroid layout, which is just another way to say that the "Center of Gravity" (CG) of one input "transistor" is at the same place as the CG of the other transistor. (I bet you can figure out that any geometry that is connected to metal labelled "B1" is a base — if something is connected to "C2," that must be a collector....)

There are many kinds of common-centroid layout, in addition to cross-coupling. You could lay out a "pair" of npns as ABBA. The "B" transistors in the middle not only reject gradients, but they can have smaller output capacitance, since they only need one tub. And in some cases, this long, skinny circuit (Fig. 3) may fit in your layout better than:

AB
BA

In this example, the transistors are still connected as an ordinary differential pair. But if you connect the transistors to act as a current reflector by shorting C1, B1, and B2 together, and merging that metal, the interconnec-

PEASE PORRIDGE

tions become *very* simple.

Recently, I saw a technical article by some engineers¹, claiming that they had a computer program that automatically provided good interdigitated and cross-coupled common-centroid layouts. "ALAS!" was what they called the program. I looked at their results. All I could say was, "Alas!!" The authors appeared to think that a layout of ABAB or AABBAABB or ABABABAB or even:

ABAB
BABA
ABAB

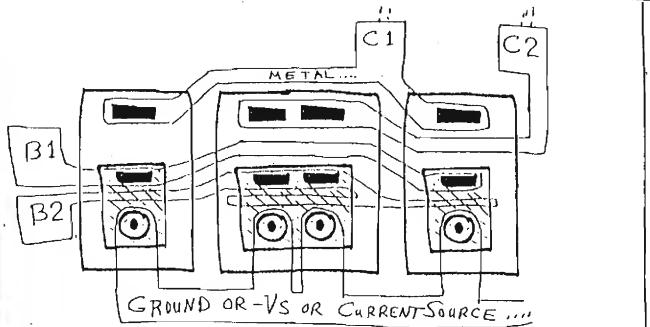
makes a "common centroid." When I apprised them of their error, they tried to argue that the magazine's computers had misrepresented their results. Uh-uh. They did not understand that *their* computers were clueless. Not only was

it a bad program that generated poor layouts, but they did not even recognize that it was a bad layout. And, heck, you don't need a fancy computer to set up pairs or groups of transistors with common centroids. I do it all the time with groups of resistors, using just pencil and paper—and lots of symmetry.

The Editor at the *Journal of Solid State Circuits* was a good sport, and gave me space for my criticism of that paper²,

and the authors' efforts to rebut my criticism³.

Often, there are significant matching errors when using transistors, or resistors, or capacitors, if common-centroid layout isn't used. There are always more-or-less linear gradients across a die. Bipolar transistors have gradients of V_{be} and beta. If there's any temperature gradient caused by output device dissipation, that's going to hurt the V_{be} matching by 2 mV/ $^{\circ}$ C, if the input transistors aren't at identical temperatures. MOSFETs are afflicted by gradients in etching, in V_t , and in oxide thickness. Adjacent resistors can have poor matching due to gradients in etching and in sheet rho. If you want your capacitor sets to match well, you must beware of gradients in etching and oxide thickness. Die stresses cause shifts that relate to linear gradients. Proper understanding of cross-coupling or other forms of "common-centroid" layout can be very valuable to help reject linear gradients across your die. An im-



TYPICAL METAL INTERCONNECT
FOR A GOOD COMMON-CENTROID NPN
"PAIR", WITH SOME DUMMY METAL, AND
LOW C_{out} on COLLECTOR #C2

Figure 3

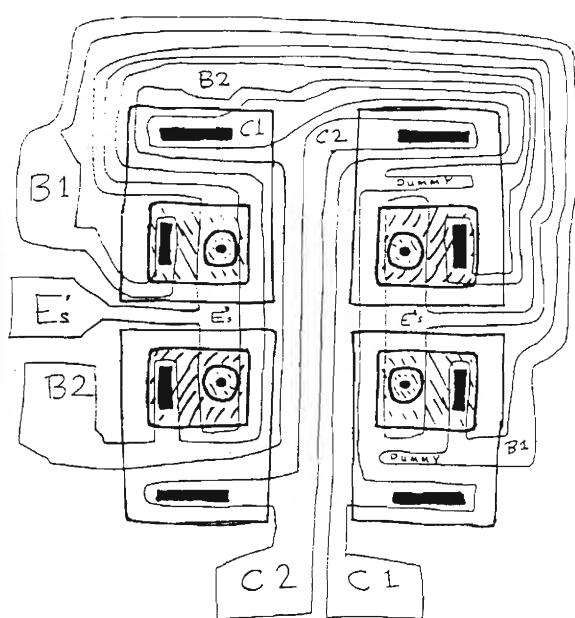
proper understanding of "common-centroid" layout can be amusing—or pathetic. If you insist on cross-coupling components that are *not* critical, you can waste lots of die space.

Back in 1972, on Jim Pastoriza's AD550 Quad Current Switch, I observed some of the limitations of laying out a DAC's transistors all in a linear row. When some bits were switched ON or OFF, there were significant thermal tails. Linear mismatches also occurred, due to linear gradients in V_{be} and beta.

I made my own layout for a monolithic Quad Current switch, with good common-centroid layout. It had 8, 4, 2, and 1 emitters—and 2 emitters for the reference. What was the Patent number? 3,995,304? You can tell that it's an old number—the patent has expired already. The emitters were laid out with the Most Significant Bit (MSB) emitters being A, the LSB as D, and the reference as R:

AAAA
BBCR
D
RCBB
AAAA

I was able to convince myself that the V_{be} matching of this kind of layout was adequate for at least an 8-bit DAC—without any emitter resistors. It may be as good as 10 bits, if I did some trimming. And much better, if emitter resis-



TYPICAL METAL
INTERCONNECTIONS FOR
A PROPERLY CROSS-COUPLED
NPN "PAIR"
(WITH SOME DUMMY METAL)

Figure 2

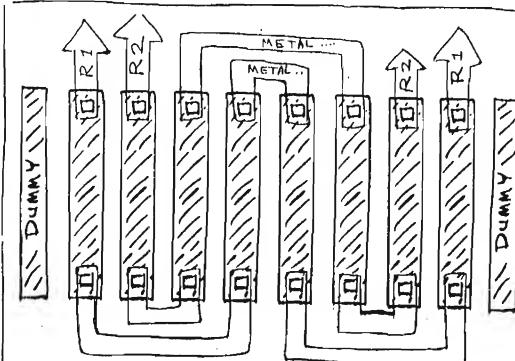
PLEASE PORRIDGE

tors were used. Heck, the first DAC I ever built was 15 bits *plus sign*.

If you use resistors, you should be aware that resistors made in a batch process tend to have linear gradients. So if you have four resistors in a row, and you want a good ratio, such as 1:1 (or 4:1), choose the two resistors in the MIDDLE. Put them in series, and take the resistors on the ends, and put them in series (or in parallel) and the ratio will tend to be more accurate. The tempco will be, too. This tends to hold true for thick-film, thin-film, or monolithic resistors. If you have eight resistors, the matching can get even better (Fig. 4). Back in '86, Dennis Monticelli asked me which layout I would recommend for the input of his LMC660 op amp:

ABAB	ABBA	
BABA	vs.	BAAB
ABAB	BAAB	
BABA	ABBA	

Where's the advantage?



TYPICAL LAYOUT OF MATCHED
RESISTORS WITH COMMON CENTROID
(AND WITH DUMMIES)....

Figure 4

I told him they were both good, but I sort of liked the first option. The offset of this op amp set new standards for accuracy of MOSFET inputs. Never a dull moment!!!!

All for now. / Comments invited!

RAP / Robert A.
Pease / Engineer

Address:
Mail Stop D2597A
National Semiconductor
P.O. Box 58090
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1. Bruce, J.D., *IEEE Journal of Solid State Circuits*, Feb. 1996, p. 271-274.
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3. Bruce, J.D., *IEEE Journal of Solid State Circuits*, Sept. 1996, p. ??.

Note: I say "???" because we don't yet know what pages those letters will be on. /rap

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with
that?



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BOB'S MAILBOX

Dear Bob:

HELP! I am being denied an analog oscilloscope. Perhaps you will understand my grief and anxiety when I tell you that I have been designing video monitors, data acquisition circuits, switching power supplies, and servo systems for more than thirty years.

I now work for a three-year old company with young engineers fresh from Cal Tech and other prestigious institutions. We design hybrid power trains for automotive applications.

We do all sorts of things—electrical motors, switching power supplies, very high-power inverters, data acquisition and processing (both analog and digital) and computers. And guess what? They use nothing but digital scopes and have a lot of problems with electrical noise (I think that there is a connection.) I have been saying two things:

1) Digital scopes do some fantastically sexy things, true, but there is still nothing like an analog scope for troubleshooting things such as "glitches," "spikes," and transitions in recurring waveforms. There is nothing like a real-time, infinite resolution display, with intensity modulation of the beam (i.e., gray-scale display), for getting the feel of a signal. (Perhaps I am like a doctor who likes his x-rays just the way they are, and gets frustrated when image enhancement is used.) But consider this—in the Product Supplement of the June 1996 issue of *Electronic Engineering Times*, on page 16, I read "...Insta Vu (the newest combination oscilloscope from Fluke) does an excellent job of replicating an analog scope, but it costs \$10,000, as opposed to \$2000 for an analog unit." A few lines later, the article also comments on the newest HP "mixed-signal" oscilloscope. What this says to me is that some engineers still want that something special you get only from an analog oscilloscope.

2) Get a Tektronix, something like the 2445B (which I own as well). It costs \$6000, has a bandwidth of 200 Mhz, four channels (a must for me) auto-zero, and other niceties. With a

cheap scope Camera (like my \$100 Shackman), I get satisfactory "gray-scale hard-copies." The point about Tektronix is that I trust what it says—the frequency response curve is well-behaved at all frequencies and probe characteristics (such as ringing) are predictable. It has gotten me out of trouble when other analog scopes couldn't help me. Bob, you've been there, what do I tell my well-meaning colleagues?

R. VAN DEN HEUVEL
Northridge, Calif.

*As I said in my *Troubleshooting book*, there's a time and a place for digital scopes to be helpful, by trapping and storing ephemeral glitches. But an analog scope is the best way to see if the glitches are there. If you have your own "personal" scope, bring it in to work. You won't wear it out by running it. And you can prove its value by spotting false modes that are difficult or impossible for digital scopes to see. I'm on your side.—RAP*

Dear Bob:

I enjoy (almost) all articles from you in *Electronic Design*. It's not just the way you look at a certain subject, but in addition, how you write (phrase, attack) it.

The article about the speaker cables in the May 13 issue is again an example of your excellent analysis. But—I think you're already waiting for this—in my opinion, you came down too hard on that poor guy George Kaye. I believe that he makes a few good points (among not so good ones). He probably didn't arrange his thoughts clearly. I'm going to give it a try, though I'm not too sure if I'll be too successful at it, either.

AUDIO analysis is exactly that: HEARING. But (another but) it is not possible to listen to a single component, or a cable, amplifier, or an isolated pickup. It's always the sum of all of the parts. In my opinion, it is (in most cases) not possible to make comparable ABX tests at all, because with today's dimensions of loudspeaker enclosures and living (or listening) rooms, you must put

one loudspeaker beside the other or above it, and that will already alter your room acoustics, or the speaker-room relationship, if you prefer. The listening room has probably a much stronger influence on the overall perception of sound than anything else.

Back to the "overall system": It is very possible that the lack of, let's assume, high frequencies of one cable due to L or C or whatever you want, is compensated by the extraordinary HF behavior of the connected speaker. Hence, if you connect this cable to another speaker, it may really sound different. (Speaker manufacturers don't build speakers for specific cables.) On the other hand, a "lousy" speaker can probably be improved by an excellent cable. But I'm fully in agreement with you: These differences, if different enough to be audible, are also measurable. I do not believe that we (the engineering society) do not have enough knowledge or enough good measurement equipment to tackle such a problem. We are able! If necessary, we can go from dc to frequencies far above the audible range and measure all relevant and not so relevant parameters. If there are differences, we'll find them.

But what about the difference of our hearing? From day to day, during the day, depending on our blood pressure, our pulse frequency, the alcohol content in our blood and so on, the list could be extended. I believe that George will not always prefer a certain cable over another one and, as said above, this will not just come from his personal well-being during that very hour of listening, but also depend strongly on the speakers he has available at that moment. (I'm coming from the area of loudspeaker development.) To make an opaque picture even more fuzzy: It also depends very strongly to what kind of music he's listening to. Here, I mean two aspects: The music material as such (folk, rock, country, classical with chamber or large orchestra, etc.) and also how it was recorded and put on disk (either CD or LP). The sound engineer can ruin a

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piece completely, even if it was recorded with the greatest care on the master tape. Compression and bandwidth limiting were fairly common some years back. Why do we have so many reissues from old master tapes today, which sound completely different than the older "original?" Not always and not necessarily better, but different.

The advances in audio reproduction equipment over the last 20 years have led us to a point to consider other components such as cables—an important piece in the whole chain, but by far not the most important one. If somebody has all the dollars and doesn't know what to do with them, OK, let him buy a pair of those esoteric cables. All others should spend more of their money on good speakers (auditioned in their home), and less on the connecting cable.

GUNTER ROEHRICHT

ESL Builders Group

Böblingen, Germany

Dear Mr. Roehricht: You're muddying the waters—saying that nobody can "listen to a single component." You say ABX comparisons have no value. In that case, if everything is chaos, the salesman who argues "These cables provide great clarity and greatly improved soundstaging" does not have a leg to stand on, does he? You're arguing that in any one particular audio system, any one person can state there is a real improvement (or a real difference) and no-one is permitted to argue with him?? Then you're arguing there can be no universal improvement—only subjectivism. You think any person is free to say, "This cable sounds better BECAUSE I say it does, in this system, at this moment." (Even if I can prove that he cannot hear any difference at all.) Well, you live in your chaotic world, I'll live in mine. The only thing we'll agree on is that spending money on better speakers is a much better investment than on expensive speaker cables.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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READER SERVICE 143

ELECTRONIC DESIGN/OCTOBER 14, 1996

WHAT'S ALL THIS SMOG STUFF, ANYHOW?

NOW some of you folks who live in other states or in other parts of the world may wonder, "What's all the fuss about smog? We don't have much smog around here." But this may affect you, too. Don't be so quick to dismiss this topic.

For a couple dozen years, California drivers have had to worry about getting their car through an emissions or "smog" inspection every two years. Oftentimes, just keeping the car tuned up properly was adequate to get you through the smog test just fine. Or, if you failed, you could get it

fixed up, and try again. Recently, a number of bureaucrats agreed on some new procedures to decrease the emissions, pollution, and smog still further. It's called "Smogcheck II." These regulations were apparently not approved or voted on by any elected lawmakers, just approved by bureaucrats. They also seem, in some respects, to have been put together by people so as to not make any sense. It also

BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

seems they are not FAIR...or rational. Some of the earliest warnings turned up on the Internet. People claimed they had seen these regulations that were cleverly worded to get all the old cars off of the road and confiscate them. Some of the laws spe-

cially written for New Jersey were (allegedly) worded so that you could not even sell your car out of state; it would be illegal to even keep your own car in your driveway after it failed a smog test. Needless to say, a great amount of screaming and worrying went on that this was completely unfair. Yet other bureaucrats argued that these fears were exaggerated—nobody was actually going to do any *confiscating*. But they never honestly told us what the laws and regulations were going to do. Very sneaky. All this stuff made me very nervous.

Finally, here in California, similar rules were put into effect without any warning—with no real notification—and with poor planning. We began to read about these new regulations in the newspapers. "All these regulations are trying to do, is to get Gross Polluters off the road. Surely no one would disagree with that." Well, that sounds plausible. That *sounds* reasonable. Hmmmm.... Then we began hearing people complain—"My car went in for a smog test, and even though I had it tuned up pretty well, it failed the test limits by just a few percent—and it was labelled a Gross Polluter."

Soon after, we began to learn other little "details." If your car is labelled as a "Gross Polluter," you cannot just get it repaired yourself. You have to take it to an Official State Repair Shop, where they do the repairs AND the testing. Furthermore, the bureaucrats underestimated that the amount of repair work needed. There were not many Official State Repair Shops, and the waiting list to get your "Gross Polluter" into one soon got up to two, four, or even six weeks. The State Repair Shops were so overloaded, they

did not even answer their phones. They just played a recorded message, "Tell us your phone number and we will call you back." Some people observed that after 10 days, nobody ever called back. In other words, bad estimating, bad planning, and too much bureaucracy.

Why is it that a failure by a mere factor of a few percent causes a "Gross Failure?" Other people were saying that a car has to fail by a factor of two to make a "Gross Polluter." WELL, it turns out that there are two ways to get in trouble—if your car fails by a factor of two, then it is declared, instantly, a Gross Polluter. Or, even if it is not a Gross (factor-of-two) Failure, if it fails the Pass Limits twice, even by a small margin, then THAT makes it a Gross Polluter, too.

NOW if failing twice gets you into real trouble, then it is worth a lot of effort to make sure you do not fail. You want to get your car tuned up as carefully as possible.

But the Fearmongers—and the newspapers—all said that the smog testers are all connected by a computer link to the main DMV (Department of Motor Vehicles) computer in Sacramento. Any failure is reported instantly. So you can't even use a smog tester to tune up your car to make sure it will pass. What a mess! No wonder the Fearmongers were worried! No wonder that hundreds of motorists turned out at rallies in Sacramento to protest.

It turns out there are a lot of gripes and allegations that are not accurately stated—not quite true—quite misleading. It is NOT LITERALLY TRUE that all emissions testers are linked up to Sacramento. If you go to a tune-up shop, or any good repair shop, you can get your car tested and checked to see if it is passing. If it is, then you can take it in to an official Smog Test Shop, and your car is likely to pass. Since it is worth a lot to avoid even one Fail, then it is VERY advisable, to get your car checked—and adjusted—before you take it in for the official smog test.

However, if there is a little miscalibration between one sensor and the other, you could have your car pass at

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the tune-up shop, and fail during the official test. THIS would be annoying. But it can happen. Some people have griped that many old cars—like a TR-6, a Jensen-Healey, a rare old Thunderbird, or a '70 Corvette—are just on the margin of passing on a good day. And any tiny glitch—or sensor miscalibration—can cause them to fail. NOW, if YOU do not own a TR-6 or an old Thunderbird, you might say that you are not concerned. Don't be too sure about that.

The bureaucrats say, "We are not confiscating any cars." And the Fear-mongers say, "We have proof that the Government is confiscating old cars—but we have promised not to tell the names." Very puzzling.

It is a fact that if you own a car that is a Gross Polluter, and you give up on trying to repair it, and you don't want to sell it out of state, you can sell it to the state—for \$450. And they will crush that car. Then they will sell the right to that pollution to some industrial company. Maybe that is fair. Maybe not.

But why can't I form an "industrial company" whose purpose is to enable cars to run? I'm sure a guy with a Ferrari, or other car that is being persecuted because of these new rules, would be happy to buy a polluting chemical factory and take *that* off the road. He would like to make that trade-off work backwards...Why not??

Maybe one of these days someone will bring in a '94 Rolls Royce that is a "lemon," and cannot be made to pass the smog test. The state will buy it for \$450, crush it, and the ensuing publicity will make the whole thing look foolish.

But it already looks pretty foolish. If the government tells you, "You failed your test by 10%, two times, and that makes you a Gross Polluter," that seems a little unfair. Then when the bureaucrats say, "And you cannot repair it yourself, you cannot get it repaired by anybody but the Official State Shop," that is really LOUSY. I cannot see the reasoning behind that.

THEN when it turns out that the Official State Repair Shop is booked solid for the next five weeks, and you are not supposed to put your car on the road until it is fixed—that is really unfair—that is *de facto* CONFISCA-

TION. I don't like it at all. I don't know how to fix it. The people that are enforcing these rules are completely insulated from criticism or complaint. Maybe somebody who is in business will take these idiots to court. Sue those idiots! That sounds good to me—throw out that arbitrary stuff.

OK, now I know about all these rules. Can I get my car through "Smog?" My 1968 VW Beetle with 340,100 miles on it?? I tuned it up. The engine has pretty good compression. The (platinum) spark plugs are almost new—only 105,000 miles old. I checked the gaps at 0.028 in., I cleaned off their insulators, and put them back in. I set the timing. I took it in to Mt. View Foreign Car.

The first thing I noticed was that the limits for a Gross Polluter are NOT always 2x the Pass Limit. For some model years, the Gross Polluter Limit was 1.2x the Pass Limit. For others it was 1.5x, or 2x, and for other models, 2.5x. So it seems that these regulations are arbitrary, and not a fixed constant factor or value. H'mmmm, *arbitrary*....

My carburetor was set a little rich. The CO percentage was running up near 4%, just barely inside the test limit of 4.5%. Not a very safe margin. So Aram, the technician, tweaked the idle volume control screw to get 1.5%—a little too lean—and then pushed it back up to 3%. Pretty safe. Stable.

I took it in to one of the smog test shops—"SmogPros." After the usual 40 minute wait, they got through with testing it. I asked, "Can I pay?" The guy said, "We have to wait to get the report back from Sacramento." I had to cool my heels for another half hour. "We don't know how long it will take, because the computers in Sacramento are overloaded." I bet....

After the half hour, the guy said, "You can see the report." The car did not pass. The emissions were OK. But the print-out from Sacramento said, "Emission equipment missing...hole in air cleaner." Well, I had taken that car in there and passed smog several times before, and never had any problem. The guy pointed out, "A 1968 VW is supposed to have a throttle positioner." Well, I've had the car over 12 years, and it never had a throttle po-

sitioner on it, and they passed it every time previously. So, this was just a sign that they are being VERY picky. Very METICULOUS...very TOUGH. As for the hole in the air cleaner, well, I could have put on some tape, so nobody could see that there was a hole. But that was not the major problem.

That was Thursday. I got the guys at Mt. View to order a throttle positioner. They installed it. That was Friday. On Monday, it passed. I pointed out to the smog testers after I passed, "The new regulations are supposed to fail old cars. I bet you haven't passed many cars with 340,000 miles on them."

So, anybody who owns a car in California, or some of the eastern states such as Massachusetts or New Jersey where these "Regulations" are being imposed, had better watch out. The rules, and the INTERPRETATIONS of those rules, are really pretty nasty and unfair. Don't be trapped or caught by rules you are not aware of. When your car needs a smog test, you should probably get your car tuned up and checked out EARLY. Then, when you have a safety margin—and when it is properly equipped with all required equipment—get it through the test EARLY. If your car needs a throttle positioner, make sure it has all the necessary equipment installed before you go for your test—avoid wasting time.

I have no idea why the rules do not let a guy get anybody who he wants to repair and tune up his car to be clean, and then come in later for an "official" test. In fact, even though they tell you that you MUST bring it in to an official repair shop, well, if you fixed it yourself, and then brought it in for an "official repair," and it just *happened* to test perfectly clean, you could tell them, gee, they must have made an error when they tested it....

I don't know why a 10% failure has to be considered "gross." But I guess that's because I am not a bureaucrat. If I were, all this stupidity would surely become *perfectly clear*.

What does this mean for people who live in different states? It seems that all cars will have lower value, because some old cars have to be sold "out of state." In other words, if you live in Montana, and you have a good old 1986 Cadillac, you may think it is worth

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several thousand dollars. But if the guy next door is able to buy a 1987 Cadillac for \$1000 because a guy in California (or New Jersey or Connecticut) had to get rid of it—then your car is NOT worth nearly as much as you thought it was.

The guys who sell cars are going to love this. They think *you* will cheerfully buy a new car to replace that 10-year-old lemon that nobody can get through smog. Well, if I just had to sell off a perfectly good, reliable, comfortable old 1986 car for \$1000 because nobody—not even the Agency—could get it to pass smog, then I am surely not going to cheerfully buy a new car. I may not be able to afford one....

Will the lines at the Official State Repair Stations get any better? I doubt it. Maybe if they let you get your own car repaired, that will help. But for the next 1.6 years, there will be a LOT of cars every month that are introduced to tough tests. Only after all cars have been through the new system once will the repair mess get better.

Will it be true that some cars are more valuable, because it IS possible to keep them well tuned up, and in spec? I guess so. What kind will that be? I don't know. But obviously, my old Beetle seems to be doing OK. If you know a mechanic who can get your Beetle through the test by twisting a screw in the right way—that sounds good to me. What are the test limits for a 1968 VW?

1968 VW TEST LIMITS

Hydrocarbons LIMIT	CO LIMIT
@ IDLE 700 ppm	@ IDLE 5.50%
My results 34 ppm	My results 0.34%
@ 2500 rpm 600 ppm	@ 2500 rpm 4.50%
My results 16 ppm	My results 0.21%

—So—don't just tell me that all old cars are dirty and fouling and polluting. A well-maintained old car can be both fairly clean and economical.

Anyhow, while this story is copyrighted, please feel free to pass it around to your friends as a public service. There is entirely TOO MUCH misinformation, disinformation, and ignorance on this subject. And if anybody learns stuff, let me know. I KNOW that I don't know the whole story, but I know

enough to be of some help.

I wish the bureaucrats and legislators would level with us. I wish they did not try to argue that a car that is 4% less than the Spec is GREAT, but a car that is 4% over spec is a GROSS POLLUTER. I wish they did not try to pretend that when the DMV tries to order you off the road until their 2-month-backlogged repair station can look at your car, that is not a form of CONFISCATION. Even if you could get your car fixed, they won't let you. And they will not tell you what you need to know. That is the WORST kind of bureaucracy.

I wish the Smog Fearmongers did not exaggerate so much. They bend the truth, and tell partially-true stories, almost as badly as the bureaucrats do. I wish not so much Bullbleep was going on....

Latest developments: In Sacramento, 46 legislators said they want to put these regulations on hold until they can rewrite them. The bureaucrats just say, No Way. I think I'll go chew on my representative's ankles.

Also, one guy pointed out that some lawyers are putting together class-action suits. They are zeroing in on the administrative errors of depriving people of their property, WITHOUT due process, AND with no right of judicial review, because of the insufficient repair facilities. Hmmmm.... They also are working on the aspect of discrimination based on unequal treatment of property based on age. Why are some of the Gross Polluter limits set arbitrarily high—or low?? Such a mess!

And as Anatole France said, "The law, in its majestic equality forbids the rich as well as the poor to sleep under bridges...." It sure is strange when we find ourselves pulling for the lawyers!

I'm in favor of clean air and low pollution as much as anybody. But let's be fair about how we do it.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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BOB'S MAILBOX



Dear Mr. Pease:

My husband, Ed Gill, (a.k.a. "Ed the Good" and "Saint Ed") gave me a copy of your June 10 article, "What's All This Hollering Stuff, Anyhow?" Mr. Gill informed me that it reminded him of me. I want to make it perfectly clear that I rarely, if ever, have cause to holler at Mr. Gill. This could be because I have seen him yell at other people—sort of like the effect your Mr. Swanson had on his co-workers.

However, I must admit I have raised my voice on occasion to others who do give me just cause. I don't see anything wrong with this, because I feel that if a person can't understand something the first (or second, or possibly THIRD) time they were told, then you need to turn up the volume and turn up the heat on the words chosen.

Just recently, I was loudly explaining something to a co-worker, which won me a trip to my supervisor's office to listen to her for a while. All my sound-bitten brain could come up with was, "I yell because I care," which, by the way, I saw on a T-shirt. I will give a copy of your article to my supervisor.

One other comment before I close—your Mr. Swanson may have been acting more from self-preservation than chivalry in opting not to holler at the "fairer" sex. Believe me, at times, there are not less fairer people on this planet when the hollering starts.

MAGGIE BOLEYN, R.N.

Blue Care Network

Southfield, Mich.

Maggie, I'm glad you care enough to holler the very best!—RAP

Dear Bob:

I enjoyed the letter from G. Roland Bradbury regarding a power circuit in a very old house that needed to "warm up" before it delivered full power. He traced it to a corroded junction between some copper bus-bars, and guessed that copper oxide or copper sulfide was acting as a semiconductor, conducting when hot, but not when cold.

While his explanation seems plausi-

ble, it struck me that there may be another one. As the bus-bars are heated by the voltage drop across the corrosion, the copper expands. Perhaps this expansion, and the resulting tightening or shifting of the joint, was what caused the improved connection.

Talk of corrosion reminded of a time, shortly after I had received my BSEE from MIT, when I fixed a malfunctioning turn signal on my father's car. I spent about an hour on it, grumbling all along about the trouble I was having diagnosing a circuit that was not much more complex than a flashlight. After all, I was now officially an Electrical Engineer! I found it amazingly difficult and time-consuming to make continuity measurements from one side of the firewall to the other. But what mainly caused my diagnosis to take so long was my assumption that the car's bumper, a heavy steel chrome-plated assembly, was surely electrically connected to the car's frame, seeing as it was held in place by four one-inch diameter bolts. I forgot what a good insulator iron oxide is! Eventually, I figured out that the problem was in the ground return, and solved it by attaching a wire from the bumper to the frame. The next day, my father mentioned to his mechanic that he was not dropping the car off to have the turn signal fixed because "my son fixed it." To this, the mechanic replied, "Lost the ground, huh?"

LAWRENCE J. KRAKAUER

Kronos Inc.

Waltham, Mass.

Yeah, troubleshooting simple things that could not possibly go WRONX is a challenge for young engineers. Fortunately, silicon dioxide is a much better insulator than iron oxide.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

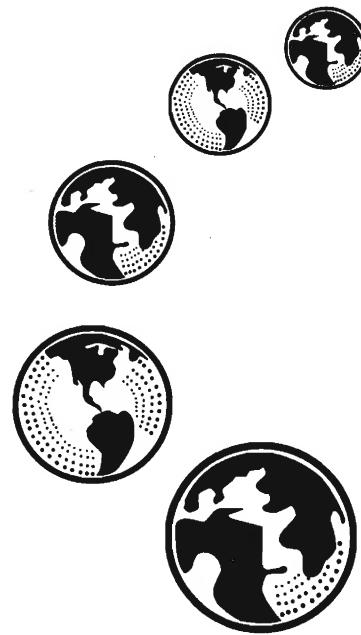
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BOB'S MAILBOX

Dear RAP:

Recently I was shown a memo explaining that all manufacture of polystyrene capacitors will cease in five years, because the only manufacturer of polystyrene film stock has quit the business. If your circuits really *need* polystyrene, you should contact your favorite capacitor supplier to make your one-time buy now. Then start redesigning your circuits.

JIM WILLIAMS

LTC, Milpitas Calif.

For many applications, teflon, polypropylene, or NPO ceramics are just about as good as polystyrene. But in special cases where the tempco or the linearity of tempco of polystyrene is ideal, you may have to go Back to the Drawing Board. Or the Bench. Or both.—RAP

Dear Mr. Pease:

In your September 16 "Bob's Mailbox," there was a letter from Robert L. Nuckolls, III, Consulting Engineer, Wichita, Kansas, who told about having a Tandy Model 100 that he bought via Compuserve that held 32k of RAM. He took it along on trips because it fit in his briefcase. He could do lots of writing with this Tandy 100. Then on his return from the trip, he could dump the contents into his computer.

Well, I called both Tandy and Compuserve, and neither one of them could tell me anything about such a device. I wondered if you can identify it further so I might look into buying one, or something similar. I do a little writing myself, although retired, and would find it very handy.

Incidentally, I enjoy your columns, and have read all of your "What's All That Stuff About..." and found them very entertaining. I sent that magazine containing those articles to a writer friend, Sam Wilson; I'm sure he will enjoy them.

JOE RISSE, PE

Dunmore, Penn.

Read the next letter.—RAP

Dear Robert:

Regarding your September 16 column: I have info that might be useful in finding yourself a Tandy 100. It seems this early laptop is still used by newspaper reporters, and a small company exists to buy, sell, and support it: Richard Hanson, Club 100, P.O. Box 23438, Pleasant Hill, CA 94523-0438; (510) 932-8856 voice, (510) 937-5039 fax, (510) 939-1246 bbs.

I use a Tandy 200 for the same reasons as reader Robert Nuckolls. It's a model 100 with a bigger 15-line display. It's harder to find than a 100, but I think the extra lines are worth the trouble. The model 102 is a "slimmer, lighter" 100. I'm told the 600 is an orphan.

In case you'd like further details, enclosed are a spare Club 100 catalog, a copy of their most asked questions page, and copies of the pertinent pages in a 1987 Tandy Computer Catalog.

ROY W. GARDNER

Santa Ana, Calif.

P.S. Did you hear Kaiser Steel and Intel are merging and are going to produce Liberty Chips?

Roy, thanks for the info on "Appropriate Technology." I may buy one myself, since it is apparently easy to interface a Model 100 to a DOS computer.—RAP

Bob:

I was very glad to see the anthology of "What's All This..." Regarding your "Mother May I?" article, here is my favorite MMI story.

A long time ago, there was this old computer system connected to a well-used bit of analytical instrumentation. The user had run out of pre-formatted 8-in. floppies to store the data for his dissertation, and the company that made the system was no longer in business. He tried to format a standard 8-in. floppy using the system and had no luck. Thus came the request for help to me.

I used the "help" command on the system and found the brief instructions on how to use the format command. I tried formatting the disk and

it asked me, "Are you sure?" I answered "Yes". It asked me "Are you positive?" I again answered "Yes."

Nothing happened. I tried again. "Yes" twice again. Nothing. "Y." "yes." "YES." "yEs." Nothing got me past the second MMI. I sent the user on a futile search for the manual. It was long lost.

I finally got so peeved at the system that I started typing all sorts of affirmative responses to the "Are you positive?" question. Some of them couldn't be printed in mixed company.

You may have guessed it by now. I finally tried "positive" as the answer to "Are you positive?", and I was rewarded with the "formatting..." response and a happy chunking in the disk drive. Needless to say, I was less than impressed with that computer system. Keep up the good work.

JOHN STANLEY

Corvallis, Oreg.

With Computers like these for friends, who needs enemies? When old computers get balky like this, they either make that happy chunking sound, or I "chunk" them off a roof.—RAP

Dear Bob:

I've been following your discussions of audiophile power amplifiers and speaker wires. Perhaps you can clarify a question that's been nagging me for several years on this subject:

If we look at the whole system, the controlled output we really care about is the position of the speaker cone, not the amplifier output voltage. In the limit, why not put a position sensor on the speaker cone and close the loop around that? For normal voice-coil-operated speakers, the displacement of the cone is proportional to the current through the speaker coil (though this is probably a first order approximation, it is certainly closer than saying the displacement is proportional to the voltage across the speaker). Therefore, why aren't audio amplifiers designed with closed loops around

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READER SERVICE 121

PEASE PORRIDGE

their output currents?

About 15 years ago, I worked for a company that made linear magnetic-deflection amplifiers (i.e. closed-loop current out, voltage in). Some of the techs took these home and had good results using them as power amplifiers for their stereos. I never delved into this further. An added benefit of closing the loop around the output current is that the amplifier is intrinsically short circuit protected. Shorted outputs used to be, and probably still are the leading cause of power amplifier failures. This seems so obvious, I'm sure I'm missing something. Am I?

HERB PERTEN

Phillips Scientific

Ramsey, N.J.

I am sure some engineers have done this, or even closed the loop with a sensor for cone position. Maybe this did not produce "the right sound." I've heard that the natural low-frequency distortion of most speakers "sounds right," and speakers that don't distort at 20 Hz do not sound very "impressive." Maybe less distortion is not as right as more.—RAP

Dear Bob:

Re the Sept. 16 Bob's Mailbox: The "thunk" Mike Middleton hears when he turns on his TV is the high inrush of current to the degaussing coil. Hit the degauss button on your large-screen color monitor and you will hear the same sound as when it's initially turned on. It sounds impressive, but probably doesn't stress any components except for the MOV in the degauss circuit.

DIRCK SPICER

Durham, Conn.

Still, if you turn on the TV or monitor 1000 times a day, that's probably not a good idea. If the degaussing coil or the MOV don't wear out, the switch probably will.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

WHAT'S ALL THIS TEAMWORK STUFF, ANYHOW?

Once upon a time, many years ago, there was a playboy who attended Harvard. He did not play football, but he hung around the football team a lot. One day, he heard all his football-player friends bragging about how they were going to beat Yale this year. In fact, they bragged that they were going to shut them out!

This guy was not necessarily very bright, I must point out. So he went to his neighborhood bookie and bet \$1000 that Harvard would shut out Yale. He came back and told his football friends how much confidence he

had in the Harvard defense to hold Yale scoreless.

His friends were horrified. I mean, bragging around the locker room is one thing, but to actually put down a lot of money, at long odds, was something else. So they calmly suggested to their playboy friend that maybe he should *hedge* his bet.

So he went off to the bookie and came back and proudly announced

that he had bet another \$1000 that Yale would hold Harvard scoreless. His friends just groaned—if he was that stupid, how could they protect him from himself?

Well, that was the year that Harvard played Yale to a scoreless tie, and the dumb fellow cleaned up, winning

many THOUSANDS of dollars, while the football players were completely *astonished*.

Now, I asked my old Harvard friend, Malcolm, if Harvard's football team ever did play a scoreless tie against Yale. He told me yes, in 1929 and 1932. Still, this must be considered an apocryphal story. Quite possibly, this bet never happened. Quite *probably* it never happened. But still, it's a story. Or, maybe it's one of esaeP's Fables....

Recently, I happened to run into a couple of young NSC engineers who had just come out of a training meeting. They were very enthusiastic about the material they had just been studying. One said earnestly, "On this new project, we are really going to *CREAM* TI. We are going to *FLATTEN* Motorola. We are going to *DEMOLISH* Analog Devices. Because we have our Teamwork going for us." The other guy spouted some more phrases that indicated he really had taken to heart some of the training he had learned about "Teams." He said, "Since we are working as a team, we are invincible, and we can solve any problem."

I winced, closed my eyes and tried to clear my head. I had heard about some of the new "team leadership" training propaganda. I thought, from what I heard, it was mostly just a lot of gung-ho stuff, a bunch of baloney. But now, some of the young engineers were talking as if they believed it was absolutely true. Just like that Harvard playboy.

At that time, I did not engage in a debate with these guys, because I knew that our management believed in "teamwork," and I did not want to be an old negative SOB, not right at the start. I decided to lie low and learn what was going on in these training meetings. After all, if we can learn

about Apples and Oranges and Taguchi Methods and Fuzzy Logic at these training courses, maybe the "Team Spirit" is just another wonderful new, modern technique.

But, if I ran into these guys again, gushing their platitudes about how GREAT we are going to be, just because we work in teams, I would take them quietly aside and ask them where they are getting their ideas from....

But I have seen that *more* and *more*, teamwork is proposed as the *right* way, the *correct* way, the *only* way to do anything here at NSC. If I am a hero, our *team* is supposed to get the credit. If I contribute to the *team*, then everything will be *fine*....

Ya know, that is a fine theory, but I am still a little skeptical. A team is still made up of *individuals*. If an idea is to be generated, it is *usually* generated by an individual. NOW, don't get me wrong. If you have a good team of people, and one guy asks a good question, which leads to another guy doing an experiment, and the data is analyzed by another guy, and one other person is then able to come up with a *SOLUTION*, hey, I am all in favor of THAT kind of teamwork.

You know darned well, one person operating in a vacuum, all by himself, can often do some brilliant work, but he can (even more often) make some stupid errors—preposterous errors. He (or she) can make dumb errors that he (or she) cannot see. One person on his own can expand these errors until the brilliant wisdom is completely overcome by the fatal flaw, and his efforts will fail. I am absolutely in favor of people checking each other out. I almost always try to get other people to check my work. BUT, that is NOT the same as "teamwork."

Let me say that another way: A mindless, Pollyanna-ish dependence on the CONCEPT of teamwork is NOT necessarily a good idea. The idea that the individual's effort should be in submission to the team spirit—that sounds to me a little like the spirit of the old Communists, or the Utopians. And we all know that the Communists had good intentions, but they could not always make it work.

Let me cite a couple of examples—not from Russia in 1934, but from NSC



BOB PEASE

OBTAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

that he had bet another \$1000 that Yale would hold Harvard scoreless. His friends just groaned—if he was that stupid, how could they protect him from himself?

Well, that was the year that Harvard played Yale to a scoreless tie, and the dumb fellow cleaned up, winning

PEASE PORRIDGE

in 1994. There was a study group to improve on the yield of a product. The yield started out OK, but the customers needed highest performance, and the highest yield on the tightest spec. And, the yield was LOUSY because that spec should never have been done. The study group was formed, as a TEAM, and had many meetings. It was harmonious. It was carefully run by a chairman. It had OARRs. (OARRs = Objectives, Agenda, Rules, Roles....) It had efficient meetings. Nobody shouted, nobody interrupted, nobody said anything politically incorrect. It came to several conclusions after several experiments.

Just one problem: It was wrong, and the experiments were misplanned, and the conclusions were wrong. The whole TEAM was headed in the wrong direction, because they did not have the right EXPERT on the team. How did I find out about this? Ah—I found a superfluous copy of the (very carefully and neatly typed) minutes of a team meeting left in the copy machine. I looked at this, and realized to my great concern, that the EXPERT on this subject did not seem to be on the Distribution List. I went to see that individual, and suggested that he should check this out and should invite himself onto the team, and straighten them out, and also see if he should not impose his wisdom onto the team and solve the problem. He did. The problem was solved, although there were delays along the way.

Who was the EXPERT not included on the TEAM? Robert A. Pease, the Czar of Bandgaps. How did the EXPERT solve the problem? He proposed a new layout, with better common-centroid layout of the main voltage-divider resistors. The new wafers finally came out of FAB, after some delays. The proof of the actual improvement had to wait until we got the parts assembled and baked, for it was the improved Assembly Shift and the short-term and long-term stability that proved this "improvement" was really good. These aspects of performance cannot normally be predicted by computers....

NOTE: Some people have argued that if we just use processes that are "well characterized with good models," we can always design circuits that will work as planned. But with

analog circuits, there are many cases where the best "characterization" of process and parts, is not helpful, not enough. The computers and the simulation all FAIL, and are of no help, only a DAMNED HINDRANCE. As for the proposal that "good models" are helpful—I disagree. Not all models are helpful. Layouts and mechanical stresses, and thermal interactions, etc., are substantially IMPOSSIBLE to handle in any computer analysis.

I have seen many places where a team can delude itself, that they are "doing great," but actually they do not know what is going on. Example: I got on a team. I proposed an improvement that would help us a lot. I wrote it down, and sent out copies to the team. I specifically asked the team members if they saw anything wrong with my proposal? Nobody said anything. We began to plan an extra bonding pad for trimming a part after assembly. We almost ran a test pattern to find the best way to do double zener-zap trim after assembly.

Just one thing was wrong: There was no available bonding pad that could be connected for after-assembly bonding. So, all my work was a minor waste of time. Several people COULD have asked me, "Bob, are you sure that connection you want can be bonded out?" But, the bad kind of team mentality was in effect. Nobody said BOO. Nobody asked the right question.

Note: In TOO DARNED MANY MEETINGS the rules are in effect, that we must not all talk at once, and we must not contradict each other, and we must not criticize other people's ideas—NO MATTER HOW STUPID THEY ARE!!!!

Right now, I cannot prove this, but I am taking this occasion to call into question—that when an idea is STUPID ENOUGH, we must flag it, rather than let it go unquestioned. Now, I must admit, there are ideas that look (at first glance) stupid, but are in fact wise, and I want to protect these ideas so they are not trashed. It's not easy to do this. But we can discuss that later. NOW, I want to raise some fairly basic questions.

What is the right way to run teams?

Where is your company's basic philosophy coming from, for the teaching

of teamwork? Where are the books? Who are the consultants? Do we really believe they are motivating our people properly?

Is this Utopian (Pollyanna-ish, I say) concept of a team, capable of doing harm? I think so. Namely:

Does it do any good to teach that teamwork will overcome all? I am nervous about any kind of absolutism. Teaching young people that they will surely overcome, because they work in teams, may be VERY DEMORALIZING when they discover they lost a test or game. Hey—the Dallas Cowboys are a team—a good one. And they have lost some games. So are the 49ers—and they can lose. I am annoyed to hear the Pollyanna freaks, saying, we cannot lose if we are a team. Because there are 12 teams going into the NFL playoffs—and 11 of them will end their season as losers.

NOW, in business, we do not win every contract, but if we think about it wisely, we can be winners if we win *our share* of the business. If we get demoralized because we do not win every encounter with competition—well heck, that was never realistic in the first place....

When I sent the first draft of this column to Gil Amelio, he proposed to veto it, as he thought I did not have a sufficiently good understanding of teamwork. He suggested I read *The Wisdom of Teams** by Jon Katzenbach, so I would understand about teams, as teams are important to our future.

I read the book—every word in the book. I understood the whole thing. HOWEVER, I checked as I went along, and Mr. Katzenbach did NOT answer my questions about unbridled, unwarranted enthusiasm for teams. The author seemed to be incapable of commenting on unrealistic expectations. He did not seem to think that we needed to worry much about solutions for teams with problem people, or bad chemistry.

NEXT, I read *Why Teams Don't Work*** by Harvey Robbins. That book was not too silly, but not terribly helpful, either. Even when it tried to say "why teams don't work," it was not extremely negative about teams. But it did not deal with the problem of excessive optimism.

I re-sent my text and questions to



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PEASE PORRIDGE

Mr. Amelio, who had moved over to Apple. I got a prompt, brief reply. Gil was a good sport, and he agreed that if "team enthusiasm" was being proposed as an alternative for thinking, that was probably a mistake. OK, we got an agreement on that.

Let me finish with a second fable—a second *team* parable:

Did you ever hear the story about the second-string quarterback (who also was the team's punter), who was put in the game because the first-string quarterback got hurt? The coach, a very strict, tough guy, a real martinet, told the kid, "Run these 3 plays and then punt." And then the coach turned away, to find out about the injury to his star quarterback.

Well, the kid handed off to the half-back, and he gained about 30 yards. Then he threw a little pass, and the receiver gained 20 yards more. Then the kid handed off to the fullback, who carried the ball down to the 2-yard line. And what did the young quarterback do next? He knew the coach wanted him to ABSOLUTELY follow orders—so he punted the ball—right out of the end zone.***

Hey, it's not every day you get two esaeP's Fables in one column. What's all this "Following Orders" Stuff, Anyhow??

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:
Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

**The Wisdom of Teams: Creating The High-Performance Organization*, J. Katzenbach and D. Smith, Harper-Business, 1993, ISBN 0-88730-676-4. About \$13.

***Why Teams Don't Work: What Went Wrong & How To Make It Right*, H. Robbins and M. Finley, Peterson's/Pacesetter Books, 1994, ISBN 1-56079-497-6. About \$22.

***If you are not knowledgeable about football, I'll explain that that was quite absurd, to punt the ball away when you are within a couple yards of scoring a touchdown!

PLEASE PORRIDGE



BOB'S MAILBOX

Dear Bob:

I'm enclosing the current issue of the newsletter which I edit for our local skeptics' group. It contains an article of mine about a perpetual motion scam. I don't know if you have encountered this one on your side of the country, but it seems to have been running nationwide for some years. You might be able to make a column out of it. There's lots of information, both pro and con, on the internet. I don't have access myself, but one of my colleagues has been passing material on to me. One link would be via: <http://www/voicenet.com/~eric/phact/> which is the PhACT's Web page.

I liked the letter from Robert Nuckles in the Sept. 16 issue who uses a Tandy Model 100 as a portable computer. I have been doing the same thing myself since I bought one new around 1983. It makes a perfect portable text input device. I can write outside, in bed, or wherever I please. If I want to pause to think, I can turn it off—reboot time is zero.

I am continually amused by the plaints of portable PC users who have 100-MHz processors, huge hard drives and backlit displays, then wonder why they can only get an hour's life from the battery. I only regret that I didn't buy the smaller, lighter Model 104 when it was being discontinued. (I recently saw a brand new Model 100 on sale at a local hamfest for \$110, so they are available.)

I bought the matching Tandy floppy drive, and some years ago, added a 32-K RAM disk to store my most used software without taking up space in the main RAM. At one time, I used the floppy drive extensively when assembling 8085 programs. (One hobby of mine is designing single-board computers round the Intel 8085.) But a few years ago, I wrote my own assembler, in Forth, to run on my Amiga, so I rarely use it any more. Now there's a bunch of maverick traits in one sentence!

TOM NAPIER
North Wales, Penn.

Hoax, scam, rip-off... when a guy claims he's DISCOVERED that an air-conditioner or other heat pump can put out more BTUs than you put in—and ALL he needs to do, is DISCOVER a new heat engine to run off this large amount of heat (at small temp difference)—and ALL he wants is \$10,000 of YOUR money to do the research—that's just God's revenge on guys who wouldn't pay attention in Science Class.... Keep up the good work, MAVERICK!—RAP

Dear Bob:

Here's a product suggestion for National Semiconductor: A CMOS 555 timer with an untangled pinout. The problem with the current 555 is that the pinout is awkward. Reset and V₊ are almost always tied together, but they're on opposite sides of the DIP. Trigger and Threshold are very often tied together, but they, also are on opposite sides of the DIP. If I had my druthers, the pinout would be:

- 1 - Ground (as it is now)
- 2 - Trigger (as it is now)
- 3 - Threshold (present pin 6)
- 4 - Discharge (present pin 7)
- 5 - Output (present pin 3)
- 6 - Control voltage (present pin 5, and tell people to bypass it to V₊, not ground)
- 7 - Reset (present pin 4, almost always tied to V₊)
- 8 - V₊ (as it is now)

I think this is the arrangement that would make the common circuits easiest to lay out, but maybe a further improvement is possible. Since a memorable part number helps to sell a product, I suggest naming this one the LMC777 or LMC5555. If it can have some kind of minor improvement in its performance (like the ability to run up to 1 MHz), to establish a market niche, so much the better. What do you think?

MICHAEL A. COVINGTON, PhD
University of Georgia
Artificial Intelligence Center

Athens, Ga.

Michael, that sounds like Genuine Intelligence. While linking from pin 2 to nearby pin 6 ain't hard, connecting pin 4 to pin 8 is an awkward path. However, 25 years of tradition will be hard to break. Your suggestion is a little late! But I'll ask anyhow.—RAP

Dear Bob:

Enjoyed your article on the "Common-Centroid Stuff" in the Oct. 1 issue. However, it was the Fairchild μA725 (not the μA714) that first used this layout technique. As I recall, the sequence of events was as follows:

I had designed the prototype μA725 in 1966 and presented a paper on it at the International Telemetry Conference in Washington in 1967. This early version was quite crude and did not contain a cross-coupled input pair.

When I proposed, and was given the go-ahead to work on, the μA741, the μA725 project was assigned to my officemate, George Erdi. I remember several brainstorming sessions in which we discussed ways to improve on its performance, including the use of a cross-coupled input stage—we didn't have a fancy name like "common-centroid" for it in those days! The sketch we ended up with on the blackboard was very similar to Fig. 2 of your article. George vastly improved on my earlier design, and the product was announced by Fairchild sometime around 1971 (it is not in the 1971 catalog, but does appear in the '73 catalog).

George Erdi subsequently left Fairchild to join Precision Monolithics as a founder, where he designed the very popular OP07, which was the first three-stage precision amplifier with internal compensation.

The OP07 proved to be so popular that in 1976, Fairchild decided they needed an exact equivalent. The μA714 number was assigned to the project, and the designer was Joseph Biran, who had joined Fairchild from Precision Monolithics. The μA714 was



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PEASE PORRIDGE

announced in 1977.

DAVE FULLAGAR

Maxim

Sunnyvale, Calif.

Thanks for telling us the real story, Dave.—RAP

Dear Bob:

As I was reading your Aug. 18 column on copperclad board, I had a few thoughts that you might appreciate. First, on the matter of cost, the best deal is for free. I learned that most electronics companies *throw out* an amazing amount of this material, usually in the form of scrapped bare boards. In one job, I was able to salvage a stack of about 50 12 x 18-in. boards that had been drilled but not etched, because of an error caught at that stage of the process. As you can guess, the uses that you're talking about won't be affected by an array of 0.040-in. holes. I've also found unetched but slightly corroded material on its way to the dumpster.

I like the selection of uses that you included in your article, and I hope you'll publish more of them as they surface. But here's one that I bet you haven't heard of. With all of this copperclad sitting around the basement, and a groundhog who continually dug his way under the garden fence, I installed a copper barrier, 8-in. above the ground and 8-in. below. The top end is tied to the chicken wire of the fence. I've seen evidence of several attempts to dig under it, but never a successful one. We also had a few groundhogs who could climb over the old fence, but with 8 in. of smooth wall at the bottom, they couldn't get a toehold with their rear paws in order to climb it. If it extends far enough below the surface, this also makes a good barrier against moles.

Here's another one: WE used to have a major problem with squirrels getting into our bird feeder, even though it was hung on a piece of 1/2-in. conduit from the antenna tower, 15 ft. off the ground. The first line of attack was to thread a series of 6-in. sections of golf tubes along the whole length of the horizontal conduit. This made it a bit unstable, but the squirrels learned to make a quick run at it and then cling to the feeder for braking. I also tried replacing the roof of the feeder with 1/8-in. acrylic, which gave them nothing

to grab when they landed on the top. But the final solution was to make a barrier about 24 in. in diameter which floats on the horizontal section about half way out, with a 3/4-in. hole through its center. Sort of like an oversized pizza pan. But it's made, of course, with copper-clad board: Two pieces joined edge-to-edge. Since then, only one squirrel has made it all the way to the feeder, but that day the feeder happened to be empty. Poetic justice. I've done other more electronic things with copperclad, but these stories are more fun to tell.

MIKE DEERING

Dimango Products Corp.

Brighton, Mich.

It's always fun to re-cycle surplus or "waste" materials. The price is right, and we can let our ingenuity run wild—as you demonstrated!—RAP

Dear Bob:

I like your articles, and in the spirit of their titles, I'd like to ask, "What's All This About Professionalism?" I worked hard to get an engineering degree, but if the company feels like it, they can hire a chemist or a physicist as an engineer. Worse, they can even hire a technician as an engineer. So why did I go to college for four years? Lawyers are not interchangeable with MBAs who studied business law, nor are they interchangeable with paralegals. Why is our profession so poorly regarded?

Anonymous

I find an infinite spectrum of good and bad engineers who never graduated from college, and a similar spectrum of ones that did. The odds that a degreed guy can do a task well is slightly better. But many non-degreed guys have a lot of enthusiasm, experience, and perseverance, TOO. I refuse to be prejudiced against guys without an engineering degree. I'm in favor of guys who CAN DO.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

What's All This Thermistor Stuff, Anyhow?

Well, I must admit that I almost never used thermistors, over the last 30 years. I knew some guys that *did* use them, but the things they were doing, I was *not*. Finally in 1980, a friend of mine was having a lot of trouble, trying to make some temperature-compensated log amps. Since he was only trying to cover a moderate temperature range, I figured I could get some thermistors to help him out. He had some bad temperature drift problems. His circuits were not behaving as expected. It turned out that he had some 1.5-Meg resistors that looked just like metal films—but they weren't. They were carbon films, with a horribly big tempco. When he put in good metal film resistors (better than 100 ppm/ $^{\circ}\text{C}$), his problems went away. We didn't need thermistors, after all. But if I did

need them, I could have used them. More recently—yesterday, in fact—a guy asked me, how can he make a precision current meter at the 10-pA level? He needed to do 0.1% accuracy. I asked him, surely the LMC662 is inexpensive and has low-enough I_b ? He said he had just discovered that amplifier, and it would improve both his error budget and his cost budget—EACH by a factor of 10 over the amplifier he had been

using. Now all he had to find was a good resistor with low tempco. He had been using some 100 gigohm (100k megohm) resistors, but the tempco was -2500 ppm/ $^{\circ}\text{C}$. Then he found that these re-

sistors had bad voltage coefficients—in the range of 0 to ± 10 V, the resistance varied 30 percent. Hey, we all take Ohm's Law for granted, but not all resistors obey it!

He had already figured out that he had to buy some resistors that were stable *and* linear. He told me that he knew he could get an effective feedback resistance of 100k megohms, by getting some good 1000-megohm resistors, and connecting them with a Noise Gain of 100, using the classical TEE network (Fig.1). The Noise Gain is $1 + R_b/R_c$, so the effective feedback resistor = $R_a \times$ Noise Gain. (This is assuming R_a is MUCH higher than R_b or R_c ; then you don't have to compute the Wye-Delta Transforms of every resistance.)

I figured I might be able to give him some advice on how to get better results, using available resistors. I suggested that a Noise Gain of 1.1 to 2 is fine; a Noise Gain of 2 to 12 may be livable; but a Noise Gain of 100 was usually not a great idea. On the other hand, he did have to get resistors that were at least LINEAR. The temperature coefficient didn't have to be *low*, but at least it should be well-behaved. Then after he had a resistor that was working *rationally*, he could, I suggested, (all this was by e-mail) easily use a TEE network to correct the tempco of his main resistor.

In the case of Figure 1, I told him he could set up a wirewound resistor with a linear tempco of $+3400$ ppm/ $^{\circ}\text{C}$, in the upper leg of his TEE network. If you choose the right values of the other resistors, you can do a pretty good approximation of flattening out the tempco of the gain. For example, if R_a is 10k megohms at -250 ppm/ $^{\circ}\text{C}$, a 1-k Ω temperature-compensating resistor R_{b1} will work with $R_{b2} = R_c = 7.5$ k Ω to cancel out the tempco of R_a . Cancelling out the tempco of even a -2500 ppm/ $^{\circ}\text{C}$

resistor is feasible. Try $R_{b2} = 0$, and $R_c = 499$ Ω . As this Z is kind of low to drive, you might try a 5-k Ω temp compensating resistor as R_{b1} , and 2.49 k Ω at R_a .

I explained that these little temperature-compensating wire-wound resistors are available from the same guys that make precision wirewound resistors—just look them up in EEM. They're likely to cost as little as \$2 (so long as you don't ask for an R value higher than a few kohms). I said that these special wirewound resistors would surely help him a lot. But he might be able to get the same job done with thermistors that cost as little as a dollar.

NOW, hasn't National been running some advertising recently, saying that thermistors are obsolete? Well, yes, for linear temperature sensing applications. If you just want a sensor to put out 5 or 10 mV/ $^{\circ}\text{C}$, you can do it with thermistors, sort of, but only over a narrow temperature range. Outside of a 30° temperature range, you lose linearity rapidly, because thermistors are inherently logarithmic. The new LM45, LM50, and LM60* are much more linear over a wide temperature range (-40 to $+125^{\circ}\text{C}$). Even over just a 40° span, thermistors don't give as good linear results.

On the other hand, in a narrow temperature range, you can use thermistors to compensate in ratiometric circuits, such as the one shown in Figure 2. Integrated Circuit temp sensors don't help you there! For example, if you have the case of $R_a = 10$ k megohms at -250 ppm/ $^{\circ}\text{C}$, you can use a thermistor as shown to fix that. First I put a 1-k Ω metal-film (low tempco) resistor R_{c2} across a thermistor R_{c3}^{**} that is 1 k Ω at $+25^{\circ}\text{C}$ and changing exponentially at $(-4.9\%/\text{C})$. This means that at 35°C , the thermistor's impedance decreases to $1\text{ k}\Omega \times (1.049)^{-10}$. Conversely at $+20^{\circ}$, the impedance rises exponentially to $1\text{ k}\Omega \times (1.049)^5$. At 15° it will rise to $1\text{ k}\Omega \times (1.049)^{10}$. (At 0°C , it would get up to 3.3 k Ω , and at -25°C , to 11 k Ω !)

I made a list of the impedance of the 1-k Ω parallel to the thermistor, as a function of temperature. Some people might use a spread sheet, but I would never do that, because I want to get a feel for the numbers. The result is that the nominal 500- Ω resistance changes linearly at $-9.91\Omega/\text{C}$, with a fairly small deviation from that



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OR CORP.,
SANTA CLARA,
CALIF.

slope (perhaps as big as $1\ \Omega$) in the 18 to 37°C range. Hey, that is a useful amount of linear resistive change!

Now in Figure 2, if you install $10\ \text{k}$ as R_{c1} and R_b , the tempco of R_c would be $-940\ \text{ppm}/^\circ\text{C}$. By inspection, this would tend to cancel out the tempco of a $-470\ \text{ppm}/^\circ\text{C}$ resistor at R_a . Therefore, with $10\ \text{k}\Omega$, we are overcompensating. Try $19.1\ \text{k}\Omega$ metal films at R_b and R_{c1} . Bingo! (Note, the computations are easier if the total value of R_c and R_b are the same, but I prefer to make R_b and R_{c1} of equal value, because the tempcos of metal film resistors from the same batch tend to match—they track better than randomly chosen resistors of different values.) (Works even better if you select adjacent resistors off the tape!!)

So if you have a consistent, small tempco in one resistor, the TEE network lets you correct the gain's tempco over a moderate temperature range. Admittedly, this is likely to work well only over a small temperature range, perhaps from 15 to 45°C , but this engineer had explained that range was plenty good enough.

On the other hand, one advantage of thermistors is that you can do some nonlinear corrections. What if the actual tempco of R_a was $-230\ \text{ppm}/^\circ\text{C}$ at $+15^\circ\text{C}$, and -270 at $+35^\circ\text{C}$? (Or, vice versa??) It's well known that if you get very far away from the linear zone of a thermistor circuit, its gain becomes nonlinear. If instead of putting a $1\ \text{k}\Omega$ thermistor across a $1\ \text{k}\Omega$ film,

you use a $1.5\ \text{k}\Omega$ film or a $750\ \Omega$ film resistor, I'm sure you'd get some dandy curvature. Something like this would be very helpful to cancel out a case of nonlinear tempco of R_a . If you want to know what the temperature *is*, IC temp sensors are quite linear and easy to apply. No computations required, no resistor networks needed.

But if you want to correct for the gain of an imperfect resistor network, thermistors can be pretty useful.

What about the case where R_a has a big tempco of $-2500\ \text{ppm}/^\circ\text{C}$? That is pretty easy to fix, too. If you set R_b and $R_{c1} = 1.21\ \text{k}\Omega$, the tempco of the R_b is about $-6000\ \text{ppm}/^\circ\text{C}$, and this is enough to fix the gain. NOW, in some cases, an impedance of $2.9\ \text{k}\Omega$ is kind of heavy for the op amp to drive, and you might even get some self-heating in the thermistor. NOT a good idea. So you might raise the impedance of all those resistors by a factor of 5, and use a $5\ \text{k}\Omega$ thermistor.

Minor item of bad news: the tempco of a $5\ \text{k}\Omega$ thermistor is usually *not* exactly the same as for a $1\ \text{k}\Omega$ thermistor, so you might have to compute the net-

work all over again. Still, a fairly minor amount of work. Less than an hour on your calculator. Much less than that, when you get in practice!

Or, since the tempco of R_a was so big, it's not critical if R_b does not perfectly match R_{c1} . In this case, you could try $R_b = 20\ \text{k}\Omega$, and $R_{c1} = 3.01\ \text{k}\Omega$, and you can keep the $1\ \text{k}\Omega$ at R_{c2} and the $1\ \text{k}\Omega$ thermistor at R_{c3} .

So the general rules of thumb I am proposing here are:

A. Temperature-compensating wire-wound

resistors can have big linear tempcos such as $3400\ \text{ppm}/^\circ\text{C}$ (or more, or less) and you can use these to compensate for undesired tempco errors in a circuit's gain, over a broad temperature range.

B. If you put a thermistor in parallel with a resistor of about the same value, at the temperature of interest, the parallel impedance will change at about $-2000\ \text{ppm}/^\circ\text{C}$, fairly linearly for a narrow temp range. If you need less tempco than that, add a resistor in series. And:

C. If you have a TEE network, and a high-value resistor R_a is changing at a certain negative rate TC_a , you can compensate this with a resistor at R_b with a *positive* tempco about twice as big: choose $TC_b = -2 \times TC_a$, OR, a resistor at R_c with a big *negative* tempco $TC_c = +2 \times TC_a$. This rule-of-thumb is applicable if $R_b = R_c$. If the ratio of R_b/R_c changes away from 1, that factor of 2 will change. So, you shouldn't think that I don't LIKE thermistors. Actually, they are quite handy and useful, if you know where and how to use them! And the engineer tried out this compensation, and he agrees it works well.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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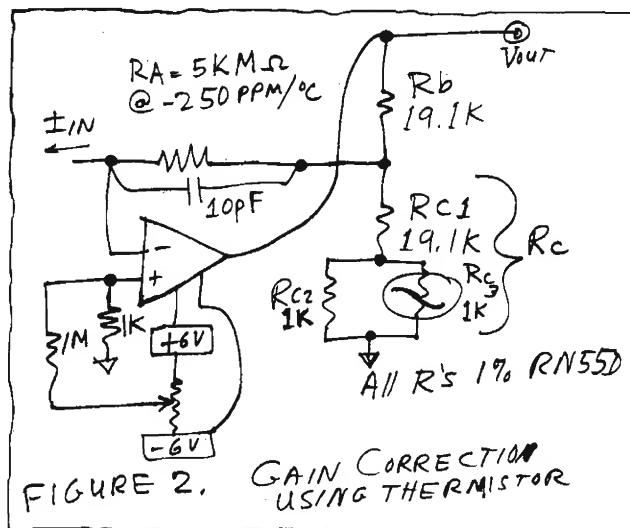


FIGURE 2. GAIN CORRECTION USING THERMISTOR

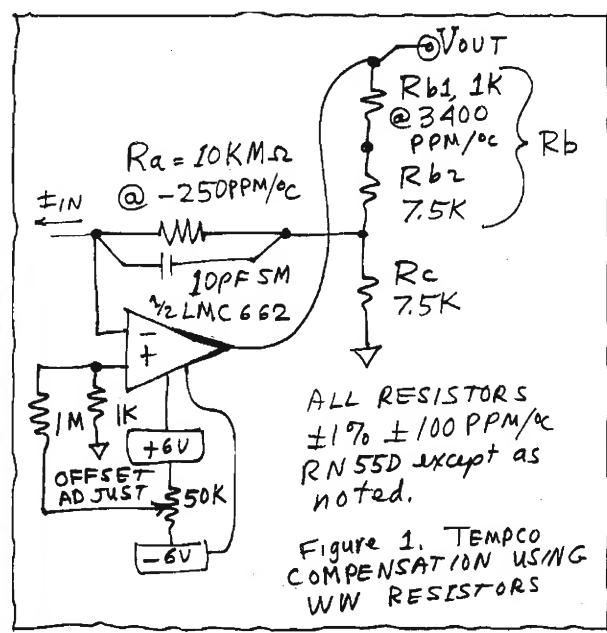


Figure 1. TEMPCO COMPENSATION USING WW RESISTORS

Bob's Mailbox

Dear Bob:

Earthing problems on cars can lead to strange phenomena. A while ago, my neighbor came rushing over to me saying when he pressed the starter switch on his car, all he got was clouds of smoke from the choke cable! This even puzzled me at first, but I soon discovered that as the engine is mounted on rubber mounts, the starter motor bolted to it relies on a heavy earthing braid to chassis. This was not making good contact, so the current found an alternate route down an oily choke cable. Hence the smoke.

MIKE DAVIES

England

P.S. I do enjoy your column, but sometimes it's excessively wordy. We tend to be a bit more economical with our words over here.

Yes, troubleshooting cars can be challenging. When the problem gets gross enough, it's easy to find, solve, and fix. But the intermittent, rare, sparse problems are tough to find.

In your part of the world, are you familiar with the saying, "I didn't have time to write a short letter, so I wrote a long one?" When I am writing a column, it's not easy to edit down. If it fits on a page, we usually quit. I apologize for being too wordy at times.—RAP

Dear Robert Pease:

Your most recent column on matching transistors was fun. I worked for dbx in the late 70's, and our VCAs were (and today That Corp.'s, the licensee of dbx patents) based on log/antilog principles. We learned very well that a bipolar transistor's collector current, over at least a 140-dB range, is so related to the emitter-base voltage. But to build a good VCA you had to have good NPNs AND good PNP. Something that was not done on ICs. So we bought transistors, matched them very carefully (at two temperatures!) and then put them into a ceramic holder.

Unfortunately, symmetry doesn't help here. All transistors must be at the same temperature for all errors to fall



toward zero. In 1977, while at dbx, I developed a circuit to compensate for errors in the VCA. At that time we could buy dual transistors in a five-pin in-line configuration. We found that wrapping aluminum or copper tape around the package helped a great deal. Then we potted the whole thing in a soft compound inside a metal can. In fact, we even layered a sheet of ceramic in the bottom of the can, insulated with a piece of cardboard, before we put in the small board with our VCA on it. (Thermal conductor, insulator, conductor, insulator, etc.) When we got done, we could touch a soldering iron to the outside of the package for seconds without it causing additional distortion in the VCA. (In a regular VCA you could touch the transistor core, mounted in the ceramic heat sink, with your finger for 1/2 second and send the distortion meter off scale!)

I've always felt that people doing high-end audio design are the best (low frequency) analog designers around. The challenges of getting audio performance to new highs seems harder than any other area I've seen. (This includes the voltmeter/instrument manufacturer that I worked at.) Designing a 6-1/2 digit voltmeter in 1983 was easier than the audio product design at dbx. Note that I don't think that all of the expensive audio gear today is necessarily high-end audio.

GARY BERGSTROM
Bergstrom Consulting
Chagrin Falls, Ohio

Yeah, 6-digit DVMs are almost easy—all they have to do is give some linear transfer. Transistors aren't nearly as easy to work with. Nor loudspeakers.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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What's All This Lecturing Stuff, Anyhow?

Way back in 1968, when I was working as a Senior Engineer, back at Philbrick, I was going to take a Christmas vacation. But one engineer who was going to give some lectures suddenly decided to leave the company. So I was suddenly invited, with barely 2 weeks' warning, to go on a 3-week lecture tour, to 4 cities on the West Coast, and to Japan. I got my passport, and went on the road on December 27 and spent a week on the Coast, and 2 weeks in Japan, and it was great fun. I had a very good time, lecturing and talking about products and ideas.

I went to Japan again in 1971 and 1973. I went to Europe in 1972 and 1974. I remember being a little surprised at the end of my lecture when the German engineers went knock-

knock-knock on their desks! (That's the German way to signify approval.) I remember the engineers in Kyoto who broke into APPAUSE when my slide show demonstrated my Voltage-to-Frequency Converters covering a 1,000,000:1 dynamic range! (They liked it in Tokyo, but they didn't applaud....) I remember several years ago, when I was with a bunch of NSC

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FAEs (Field Applications Engineers) down in Santa Cruz, and Charlie Mitchell, the head of the FAEs, hollered across the room "Hey, Bob Pease." I walked over to

talk to him, and he said "Hey, Bob, how would you like to go lecture in Europe?"

I told Charlie that sounded like a good idea, but I'd have to check it with my boss. Well, my boss liked the concept, but another senior engineer had more seniority, and he deserved to go. So I didn't go that year. But maybe it is now my turn. I have outlived all the other SOBs, as the old story goes.

I have usually enjoyed travel, domestic and foreign. And I have always enjoyed talking with customers, and friends of linear circuits. So I am ABSOLUTELY looking forward to going out to give some lectures.

I remember back in 1980, I went on the road for a week with the NSC Linear Road Show. We were winding up our week, lecturing in the Newark area. All the other guys had booked a flight back to San Jose that left at 5:30 PM. If they left before 4:40, they could easily make the flight—but that would leave me to close out the show all by myself. I said—No problem, let's do that, because my flight to SFO doesn't leave until 8. At about 4:30, I saw them all tippy-toeing out the back door. I waved discreetly. I finished off the lectures, and the quizzes and answers, and door prizes. And all the Questions and Answers. And I talked to all the guys who hung around after the main session to visit and talk. Then after everybody left, I started to roll up all our wires and gather up all our equipment. A phone call came in from the head of the Road Show.

"Bob, is there a little brown bag over in the corner?" I said, Yeah. "Well, take good care of it, because there are several hundred dollars of gate receipts in there." So I scooped it up and put it in my suitcase. That was no problemo.

It turns out, the laugh was on them, as my plane got me home before theirs did. That's because their plane had to make an extra stop to refuel in Salt Lake City, and was delayed considerably.

I have recently been invited by some colleagues, to "drop in," if I am in the area of New Jersey or Boston or Baltimore or Rochester, N.Y. to give a lecture. Well, I may just be doing that. BUT FIRST, I have to plan—what the heck should I talk about?

I will OBVIOUSLY be saying some good things about new linear circuits. Maybe even some good OLD ones. GOOD applications. NEAT tricks. I will surely say a few good things about *Electronic Design*. They are pretty good guys, and they have let me say good things about Analog Stuff. In fact, when we asked the guys at E.D.—would they like to co-sponsor my Lectures — they agreed! So that is nice, to let them in on the fun....

Of course, I will talk about analog circuits, and analog techniques. Maybe about Analog Multipliers. Or thermistors. We don't even make them. Things like PID. I might have a little DEMO on PID. My Ball-on-Beam Balancer is a fun circuit, but at 4 ft. x 1 ft. x 1 ft., it's NOT a good demonstrator to drag all over the countryside. Maybe I could design one 6-in. square x 3-in. high. That would be fun.

I will talk about various topics that have come up in my columns, and expand on them. I will mention my Troubleshooting book. I will mention my new book on "How To Drive Into ACCIDENTS—and How Not To." I do not plan to lug around a whole lot of books to sell, but I may bring along a few. I'll surely talk some about airborne computers—the natural result of the topic, "How to tell when your computer is lying".

I have given MANY kinds of lectures. I once even tried to give a lecture without slides or foils, to a bunch of 6th graders, and it nearly killed me, because without foils, I am not organized to do that.... I can use some slides, maybe a little video, mostly home-brew foils. Hand-made foils, and *audibles* made up at the line of scrimmage.



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Anyhow, I will be going on the road to give a good round of lectures. They will be in a "Pease style". They will promote Analog and Linear Stuff, good thinking, and good ideas in general. I am sure it will fluctuate between *entertaining* and *educational*. After all, I have given a LOT of lectures in the last 5 years, to various IEEE and industry groups—such as a Keynote Lecture for an Embedded Systems conference, and an ASICS conference. Also, lectures to an IEEE Management Society, and an IEEE Measurement Society, and lectures on Fuzzy Logic to various IEEE groups. Lectures to several engineering school groups and industry retreats. Not to mention a wrestling match with Earl Cox. So you can see I am not exactly out of practice. I have lots of ideas that have never been in any column, that I can talk about in a Lecture. I think I can make the Lectures fun and educational.

NSC used to have seminars and Linear Applications lectures for an entrance fee—sometimes as much as \$25. It does seem likely that we will have to charge for these lectures. I was hoping that we could charge just 2 cents. We could have run a little Ad: A picture of 2 pennies, with the text: "You can give Bob Pease your 2-cents worth." But the marketing guys said we had to charge \$50. I guess that's the deal. We'll be kicking off the lecture series in the following locations:

Los Angeles, Calif. ----- March 21
Seattle, Wash. ----- March 24
Denver, Colo. ----- April 11

I hope all my fans, and all fans of Analog Stuff, will be able to attend: "*What's All This Analog Stuff, Anyhow?*"

To register for the Lecture nearest to you, or to get more information, call (201) 393-6055—OR, Fax to (201) 393-6073. Or, go to the Web Page at <http://www.penton.com/ed/>.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:
Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

Bob's Mailbox

Dear Bob:

Re: "What's All This Stupid, Dangerous Stuff, Anyhow?" that appeared in the Oct. 24, 1995 issue. It's a little late, but I still wanted to tell you this one so that you might add to your collection of crassly stupid things we've done.

While at Mainz, West Germany with IBM from 1966 to 1974, our modest Analysis Laboratory—a production support facility—grew into a significant adjunct to IBM European research labs. I participated in research on thin-film disk drives and heads, "voice-coil" head positioners, and the original Winchester drive, to name a few.

This kept a young technician with only Air-Force electronics training and many hundreds of hours of self-directed practical training (lots of standby duty), really hopping (and studying).

Many incidents qualified for Hall of Duhh. For example an engineer applying 220 V/50 Hz directly to our brand new Tektronix 1S1 sampler input to "see if it worked." But one incident stands out:

Four or five scientists from Sindelfingen, FRG, and the Zurich, CH labs had come to observe our measurement techniques on an experimental disk of their making, using a variable-speed tester we had built. The design was based on the 2311 disk drive, a small free-standing unit.

Complete, the unit was about 36-in. tall, but it had been stripped down to the cast-aluminum base plate for access. The dc spindle drive motor was capable of 6000+ RPM with load, had great speed regulation and dynamic braking.

We mounted their 1/4-in. thick, 14-in. diameter glass disk on the standard spindle with hard paper shims. The test disk was a thing of beauty, with a sputtered iron-nickel film.

As our virgin disk first spun up toward 6 grand, I casually asked what kind of glass this was. Our visitors exchanged glances, shrugged and said it



was standard plate glass from a Sindelfingen glazier. It took about two seconds to realize that this possibly stress-riden monster was at a height located just below the belt with thin air as a shield. I immediately turned sideways and reached around to the vernier-dial speed setting. I

cranked it down as smoothly as possible, rather than hitting the ac power switch which would have applied the dynamic brakes full-on before actual shutdown. My boss brusquely asked what I thought I was doing! I commented on my wish to retain my ability to father children and it finally dawned on them.

The next day, we were once again watching the spin-up, but protected by inch-thick aluminum sides and Plexiglass top cover. Thought this might bring a nervous grin to your grizzled visage. And thanks for the mixed Porridge, Pease.

STEVE ALLISON

TEKcellence

Ramon, Calif.

I'd have hollered "INCOMING" and dropped to the floor. And on the way down, I would have turned down the speed, smoothly, as you did. I guess the next day the disk did spin up to 6000 RPM, safely, or you would have said so.—RAP

Sir:

I've followed the Tandy 100 thread in your "Bob's Mailbox" column for Sept. 16 and Nov. 18th. The letter that follows was typed a half-hour ago, just before my fancy '486 locked up with a simple "No more handles allocatable. System Halted" on the screen. I think you'll catch the relevance!! You may wish to check an interesting web site:

<http://lenin.cc.rochester.edu/orphan/orphan.html>. It has resources for owners of "orphaned computers." The

Tandy 100 is one of the computers covered.

After owning a Tandy 100 and the Minisport, I think you may not wish

to bypass looking at the Zenith Minisport. I purchased four of them back in 1991. Fifty bucks for working ones, and \$25 for nonworking. I ended up selling two for a profit, and still use the other two now.

For two years, I published a newsletter about the Minisport. You can poke around a SimTel archive and find a compendium, or search for the phrase "mlhack" on the Lycos web search engine. Or, you can get link information from my home page: <http://www.pcisys.net/~mork/>.

The Minisport has all the Tandy 100 does, and more. It has a full 80-in. by 25-in., almost identical footprint. It has 1 or 2 Mbytes of memory, and any memory that's not used for system memory is available as a RAM disk. It's an 8088 with MSDOS in ROM. Using Stacker, I now have a 640 k MSDOS machine with a 3 Mbyte RAM disk, plus the on-board 2.5-in. floppy. Plus a modem port. Plus serial/parallel compatible with the PC world.

It comes with a FTP-ish program that will squirt itself through the serial line into another PC/MSDOS computer, and then allow free transfer of files back and forth. During three military deployments to Europe and Saudi Arabia back during Desert Storm, I was able to carry a Minisport around with me, and wherever I was, transfer programs and get laser printed hardcopies from whatever office I was currently in. Not to mention, backup on to hard drives.

Anyhow, I thought you'd be interested that there's more than a small group of people who've had enough of the \$4000 multimedia laptop.

BRIAN J. MORK

USAFA, Colo.

Brian, thanks for the Minisport ideas. But, I just bought a Tandy 102. It's perfectly adequate for my ASCII typing. Still, I appreciate the clue on the website for orphan computers. Wonder if my ADAM is listed.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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National Semiconductor
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Santa Clara, CA 95052-8090

What's All This FLOOBYDUST Stuff, Anyhow? (Part 5)

AT HAND: I have carried a pretty good jack-knife for about 50 years. But it wasn't the *same* jack-knife, it was about 40 different knives. Obviously, it's easy to lose a jack-knife, or leave it behind. I've done it dozens of times. It is not just annoying because it's expensive to buy the replacement knife; you may have to wander around without any knife for a while until you have a chance to buy one. (You can *partly* alleviate this by buying 2 or 3 knives when they are on sale....)

Recently, my friend Will Frangos said, "Take a look at my Swiss-Army knife. Have you ever seen one with a blade this narrow?" I agreed; it looked like he had been using it and sharpening it for many years. He explained that he, too, always used to lose his

knife, every few months—but he decided to tie it to a cord, a tether tied to his belt, so it would not get lost. Consequently it was going strong after 10 years.

I thought about that, but I didn't like the idea of a simple cord. If it was long enough to let me do useful work, the cord would be too floppy and bulky. I remembered the retractable cable for keys that key shops sell. I bought one. The legend



BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

stamped onto its back reads: "KEY-BAK", US Patent 2732148. Mfd. & Exported by West Coast Chain Mfg. Co., Box 9088, Ontario Canada. Distributed by CTL Co., Wausau WISC. Assy. in

Mexico." This little reel, about 2-in. diameter by 1/2-in. thick, and weighing just 2 ounces, clips on to my belt.

When I need my knife, this cable reels out of the reel, as much as 4 feet. When my work is done, the cable reels back in. In addition, I put in a double strand of black shoelace to link from the knife to the cable. Then, when the cable is all the way up, the knife sits comfortably in the bottom of my pocket. I won't be buying very many knives for a while. If you like to carry a jack-knife, I can recommend this.

I got a copy of that old patent. The original design had a light chain. The newer version with the cable seems nicer. Some key stores sell that "Key-Bak" for about \$14. Others sell it for \$8. Whatever.

A while back, I had a dream where I was trying to protect a couple of old ladies from a vicious snarling, threatening monkey. I got out my jack-knife, and I confronted the monkey. Soon the monkey made a savvy move, and bit my hand—and grabbed the knife. But not for long, as he did not comprehend the return spring that brought the knife back to me before he could bite the shoelaces. Even in dreams, a jack-knife is a handy gadget....

MEASUREMENT ERROR? NO, a thinking error. A while back, in my Measurement Stuff Column, I said that my thumbnail was 12 milli-inches thick—and thus just 0.45 millimeters, not a whole millimeter as the Trivia Man said. One reader caught me up: "Bob, 12 milli-inches is NOT 0.45 mm, it is 0.3 mm." I went back and checked my math. Obviously, I had divided by 25.4, when I shoulda divided by 39.37. That's pretty dumb!

I usually am careful to start out: "1 meter is 39.37 inches, and 1 cm is 39.37 centi-inches, and 1 mm = 39.37 milli-inches. Then 0.3 x 1 mm would be about 12 milli-inches." IF you start

from basic definitions, and use CORRECT dimensional analysis, you can avoid being fooled. I recommend good dimensional analysis. More later.

NOTE: While we all know 5280 feet is a mile, it is also useful (and convenient) to know that a kilometer is about 3280 feet, so when you are working with elevations, you can work with that. A mountain at 3,000 meters is 3×3280 feet high, or about 9840 feet. Much more precise and useful than "0.62 mile."

However, it is a surprise to find that 3280 feet and 10 inches is EXACTLY 1 kilometer. Not just approximately, or within a couple ppm, but EXACTLY. (Note, 2.54 cm is NOT exactly an inch. It's exactly 2 ppm shorter than an inch.)

When we did the Column on Measurements, a few months back, Roger Engelke, formerly the Chief Copy Editor at *Electronic Design* was horrified by my usage of "milli-inch," because he could not find it in any dictionary. But we got it published, anyhow. If he sees "centi-inch," he'll just DIE.

Maybe I should explain about the "ranchette." The "ranchette" is a unit of area defined as 1/2 pico-acre. The ranchette is exactly the size of a round emitter 1.0 milli-inches in radius (well, 0.9983 milli-inch), so it really is handy when dealing with large matched pairs of transistors. NO, I did not invent the "ranchette." I read about that, years ago. Yeah, let's include this and give Roger a hard time. Meanwhile, does anybody know to whom we should give "credit" for inventing the "ranchette"?

LAPTOPS—OKAY, you have seen me swap letters back-and-forth with several guys who talked about the advantages of the Tandy Model 100 or Model 102. And you know my opinion of hog-at-the-trough Pentium computers, fancy window-type formats, and power-hungry color LCD displays. (Heck, I cannot type at 166 MHz, 66 MHz, 66 kHz, or even 66 Hz. How about you?)

So you won't be surprised to hear that I got me a Model 102 from one of my readers who was going to give his to the Salvation Army. I figured that anybody who bought it at the Salvation Army would not know what it's good for. But I would. So I made it a home.

Good news—the keyboard is full-

sized, and QUITE adequate and comfortable. NOT chiclets. Good news—the version with the full "32k" has an actual 29 kbytes of memory available, which is usually enough for an all-typing weekend or a 3-day business trip. Excellent news—the battery life (4 alkaline AA cells) is over 16 hours, and I can fill it up with 28k of typing in less than that.

The display is just 8 lines by 40 characters, but I can live with that. Moving around on the display is not very quick—but it's livable.

The little \$10 cable and the \$20 software that you need to transfer a file into a PC are a piece of cake. Its Word Processing system is quite adequate, and sufficiently user-friendly. Not a bad machine. The Model 102 weighs just 3 lb, slightly less than the older Model 100. It's like new. It will probably last forever.

If you are interested in a good old Model 100 (ballpark of \$250) or a clean Model 102 (about \$450), contact Richard Hanson. You can e-mail him at richard.hanson@pcl.com; or fax to (510) 937-5039; or phone to (510) 932-8956; or write to Club 100, P.O. Box 23438, Pleasant Hill, CA 94523-0438. These computers USED to be cheap, but now as they are getting better appreciated, the prices are going up. What that means is that Mr. Hanson will be able to make enough \$ to keep them running for over 5 or 10 years more. I'll cheerfully pay to make sure that happens.

POSTAGE BY THE OUNCE—Recently, I got a letter from a guy asking for the answer to last year's April Fool's question on zenering the emitter of a transistor. He was nice enough to put in a SASE for my convenience. BUT he put two stamps on it. Well, perhaps he could not be POSITIVE my reply would not be over 1 ounce, so he put on two stamps.

Then I looked at his letter to ME. He put two 32-cent stamps on *that*, TOO—and he just had two pages in it. Hey, I like our postal service pretty well, but I hate to pay them *double*. I like to put just enough STUFF into my envelope to bring it up to 0.95 ounces, or 2.95 ounces, or whatever. I like to get my money's worth whenever I send a letter. That often requires me to leave out a couple clippings that will be sent later. When I am sending JUNK, I have to

weigh it. But when I am just sending letters, I know that 4.8 pages of ordinary photocopy paper, when put in an NSC envelope, weighs just under 1 ounce. If I want to send 10 pages, that's still under 2 ounces, and costs 55 cents. NOTE: A lot of people know that the second ounce (and each succeeding ounce) does not cost 32 cents—it just costs 23 cents. So 7.9 ounces will cost $8 \times 0.23 + 0.09$, or \$1.93. This is easily done with six 32-cent stamps *plus* a 1-cent stamp. It's a lot cheaper than just throwing on EIGHT 32-cent stamps.

(But when you get up to 13 ounces, which sounds like it should cost \$3.08, STOP. From 13 ounces to 2 lb, it is a flat rate of \$3.00, for First Class mail ("priority mail" = air mail.))

Postage for AIR Mail to overseas locations does cost 60 cents for the first half-ounce, BUT only 40 cents for the second half-ounce. So a full 1.9-ounce letter costs \$1.80—NOT \$2.40. The post office does not publicize this very much.

Mail to Canada is 46 cents for the first half-ounce, and 52 cents for the first ounce. From there on it is nonlinear: 72 cents for 1.99 ounces, and 95 cents for 2.99. Postage to Mexico is nonlinear, too.

A friend once sent me a letter with 78 cents worth of stamps—enough postage for 2.9 ounces. But the letter did not seem heavier than 2 ounces. I weighed it. It was about 1.95 ounces—and 55 cents shoulda been enough. I called him up and asked why he put on 78 cents. He said he checked it at his company mailroom, and it was just over 2 ounces. I suggested he should get those scales checked for calibration. He did, and they were right on. So was MY scale—right on.

We figured out later he was in a damp, humid climate. By the time his letter got to me, it had gotten enough drier to have fallen from 2.05 ounces to below 1.98 ounces. If you live in a damp place, and if you had a letter that was just 3.02 ounces, and if you only had 78 cents of stamps, you could put the envelope in your toaster-oven at 150 degrees for a couple of minutes. Then it would drop down below 3 ounces, and would go legally for 78 cents instead of \$1.01. This is not always a great way to save money, but if you are about out of stamps (and if you have already snipped off the borders of the paper)

this is a possible way to get the weight down just a little.

But, in general, as a rule of thumb, if your envelopes are not extremely heavy, you can mail AT LEAST 4 pages, and usually 4-1/2 pages, of ordinary paper, for 32 cents. If you have random stuff, you could check to see if it weighs less than 9 new zinc pennies (pennies made after 1985)—and THAT would be less than an ounce. Okay? If you are not sure, make up an envelope full of stuff that ought to weigh 1 ounce, and take it to the post office, and fiddle with the contents until it weighs just 1 ounce. You can keep that letter and use it for calibration. Calibrate your scales, and save money.

By the way, how often do you readers write a small P.S. on a small piece of paper, fold it over 3 or 4 folds, until it is like a popsicle stick, and *poke* it into an envelope, along the glued joints, after you sealed it? I do it often.

MOISTURE DETECTOR—Recently, I had a drain clog, and my dishwasher started to pump water all over my kitchen counter and onto the floor. After I cleaned up the puddles, I decided to make a moisture detector. I just happened to have around a couple of 12-V "buzzers." I tried four different buzzers from Radio Shack: Models 273-055A, 273-059, 273-029, and 273-060. These are all adequate as a beeper or noisemaker, and all are priced reasonably at \$2 or \$3.

I took an old 9-V battery and some old copper-clad, and a little 9-V connector (that I'd salvaged out of the top of a dead 9-V battery). I got an old piece of wire (that was the handle for a Chinese-food take-out basket). I decided that was JUST stiff enough and just springy enough. I soldered it to two separated areas on the copper-clad (where I had sawed with an old hacksaw to insulate them.) The two separate wires I adjusted so they would short out, with normal spring-loading. Then, I put an aspirin between the two wires. When the aspirin got wet, the wires would short out—and the buzzer would buzz.

My wife said, "The aspirin won't dissolve. It takes stomach acid to dissolve the aspirin." I told her I had always heard aspirin was good for this. So I put some water on the aspirin as a test. Sure enough—the beeper began to beep—in about 10 minutes. Not the response time I wanted!! But a half of a



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sugar cube works better and faster. It collapses and fires in about 6 seconds. The only minor problem I foresee is if I put this in a cellar to detect for leaks, would dampness cause any false alarms? Or would the ants attack it? Still, it could help warn about problems with leaks or water-heater failures.

THERMOCOUPLES?? A friend asked me what kind of a thermocouple puts out 700 mV, like the one in his gas stove? Well, we know that does not run at 2000°C, so it must not be any ordinary 40 μ V/°C thermocouple. It probably uses some kind of exotic metals or semiconductors. Can anybody tell me what is used in them? I'd like to know. It is obviously not a thermopile or stack of several thermocouples.

SMOG, REVISITED—I got a lot of information (and a lot of disinformation) about smog. To this day, the State of California (and almost all the "media") do not give a fair or correct definition of what a "gross polluter" is, nor do they talk about the best way to avoid having your car declared one—by getting it adjusted and repaired and tested before you take it in for the official tests. SIGH.

We DID learn that the State of California cannot confiscate your car just because it does not pass a smog test. **HOWEVER**, in some cities, such as San Jose or Santa Cruz, they have "abatement programs." The local "abatement officer" can "abate" your car right out of your driveway, if it is not registered, and can scrap it, and take the \$3000 abatement charge, and sell it to some darned refinery or other polluter. Wonderful....

(Heyyyyy — a car that is not registered, and is not on the road, does not emit any smog *at all*. How come they think they are cutting smog by junking such a car????)

TIP: If you buy some shoes, and you like them, go back and buy another pair before you forget. If you wear the two pairs of shoes alternately, they will last longer. And, that way, you won't be cross to discover, when they are worn out, that you cannot buy them any more!

A friend brought in his new GPS receiver, and we went out in the parking lot to compare his data to mine. Sometimes *his* receiver made a 50-meter *lurch*—and mine didn't. Sometimes *my* receiver made a 40-meter *jump*—

and *his* didn't! I surely was not expecting that. I had expected many of the lurches to be the same! Still, both gave acceptable accuracy. (Even if they did both list the elevation at -100 or -180 feet.) And they'll get better in a couple years when the Air Force turns off the noise. But, beware, as it is claimed that some older GPS receivers may experience "millennium" problems as early as August 1999.

BOOK REPORT—I got a good book in the mail yesterday, written by Jim Smith (of Cambridge Management Sciences, formerly The Phoenix Group) about Quality. He debunks a lot of myths about Quality. He explains why certain "Quality" procedures are good, and others are bogus. I am recommending to our librarian to get a copy or two. It is a big book, 520 pages: "Optimizing Quality in Electronics Assembly: A Heretical Approach," by James Smith and Frank Whitehall (McGraw Hill). Costs about \$50.

I haven't found too many places that deal with the design of ICs, as it mostly deals with the assembly of ICs. So it should be of great value to our customers, and to us, when we are communicating with our customers.

Good writing. He points out the flaws in "the customer is always right, so give the customer the Quality he asks for." He DISMANTLES the Six-Sigma theories. He sorta likes a lot of the ideas of Juran, Deming, Crosby, and Feigenbaum—but not ALL of their ideas. I was pleased to see that he likes about ALL the ideas of Eliyahu Goldratt (*The Goal*). Conversely, he does mention Genichi Taguchi and his methods. He then prints some nice excerpts of how I was able to show that Taguchi's "optimal" regulator was not regulating at all (ELECTRONIC DESIGN, June 10, 1993, p.85). Anybody who is that realistic about Taguchi, and who is VERY SKEPTICAL of ISO 9000, I gotta like. A lotta good stuff in there. I have not finished reading all of it, but I've read half and skimmed the rest.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:
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National Semiconductor
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Santa Clara, CA 95052-8090

Bob's Mailbox

Hi, Bob:

So you don't like prepackaged team spirit. Your problem is, you prefer common sense to hard science. For example, the Fuller Brush Company has demonstrated over the last 55 years that every buck spent on team spirit has yielded \$2.47 in additional profit, or an increase of 21.397%. How can you quibble with that?

Here's my own favorite teamwork tale from the waning years of the RCA Microwave group. I had been working on VERY advanced TWTs for many years, then shifted to GaAs amplifiers. One day, a former colleague who had switched to the greener pastures of management asked me whether I was participating in the "TWT Replacement" meeting. Nope. "But you're the only one in the building who has done BOTH," and Roy forced my presence down our Princeton team's gullet. (Boy, was he still green!)

With the assembled luminaries, I heard how our scientists were going to replace 8 to 18-GHz, 25-W tubes with solid-state amps. Then my turn came: I just drew power/gain/frequency curves on the whiteboard, first for my old tubes, and then for my new GaAs amp. (Singular—it was the only one EVER SOLD by the whole outfit.)

The sudden end of the "TWT Replacement Project" and its funding embarrassed even me. How can ONE real engineer defeat a whole gung-ho TEAM of EXPERTS in 5 min. flat! About a year later, RCA sold the TWT operation to Raytheon and closed up our shop.

Speaking of EXPERTS: I just came across a 1971 story in LIFE magazine about Tom McCusker's robot named Shakey. Seems its future had been questioned by Datamation, among others, but LIFE's Mate Scott was adamant about the "soundness" of the report. "Both Dr. Marvin Minsky and his colleague Dr. Seymour Papert estimated a 3- to 8-year timetable for the creation of a machine with the average intelligence of



a human being." (Honestly! Copy enclosed!)

Here was the father of Artificial Intelligence himself, back in 1971, at MIT no less! Well, artificial intelligence simply never had a chance against natural stupidity. That goes for software as much as ANY kind of hardware. So don't you retire

anytime soon!

MAX J. SCHINDLER
Boonton Twp., N.J.

Yeah, one solid FACT is worth 10 buckets of wishful thinking. But are TWT's still any better than solid-state amplifiers, except for POWER output? As for Genuine Stupidity vs. Artificial Stupidity, that's a tough battle.—RAP

Hello, Bob:

I really enjoyed your Sept. 3, 1996 column. Measurements are my mania. Measurements are the essence of engineering and science; and I mean good, repeatable, precise, rational, and standards-traceable measurements. For the first two years of my engineering career, all I ever seemed to be assigned to do was repair equipment, track down ground loops, and measure, measure, measure.

Now, I'm very happy my mentors tormented me that way. I learned how to make measurements and operate test and measurement equipment. Often, I did not get to use the latest and fanciest gear, like the Fluke DVM. I had an old Simpson 303 VTVM and a 206 VOM, some old Tek 53X scopes, a GR R-L-C bridge, and some passive standards.

Even today, I still prefer the simplest approach when making measurements, like measuring cable phase delay with a vector voltmeter and sinewave RF generator, rather than a TDR. Moreover, I was taught to determine the overall accuracy of the measurements, and to compensate for the measurement system's accuracy. All measurements that went to customers or into my log were accompanied by a calculation for, and a statement of, the accuracy and traceability

of the equipment. I never see that done today—by anybody.

I'm always suspicious of test equipment that purports to be self-compensating of its own measurement accuracy, as you so well pointed out. It's best to regard measurements with some skepticism and to validate against something of known value. It just might save you from disaster or disgrace!

via e-mail
JIM MEARS
Principal Engineer
Interface Products Group

Yes, there really is a difference between those who can measure, and the rest of the world.—RAP

Dear Bob:

Re: The letter from Herb Perten in the Nov. 18, 1996 *Bob's Mailbox*. Infinity Systems did have a speaker with a servo loop—their "Servo-Static 1," ca. 1972. The servo loop was on the combined channel subwoofer, which covered from 20 Hz to 110 Hz. The "Static" was in reference to the electrostatic panels for covering 110 Hz to 2 kHz, and 2 kHz to 20 kHz. I got a chance to hear one at the 1973 high-fidelity show in Burlingame.

The key parameter for the servo loop is the speaker cone *velocity*, not the position. The audio signal is proportional to sound pressure, and the pressure is generated when the cone moves. One exception would be in a small well-sealed car with large speaker cones, but I'm not really sure about subjecting my ears to that kind of abuse.

Even with a servo loop, there is another kind of distortion to look out for—Doppler shift from the moving cone. This is actually worse for the mid-range and above due to the smaller cones. This may account for my preference for electrostatic speakers. The velocity of the panels can be kept low due to their relatively-large area. I ended up buying a pair of Crown hybrids as a result of hearing them at the '73 show, and still have them.

ERIK MAGNUSON
Research Engineer
Quantum Magnetics
San Diego, Calif.

The theory on servo speakers leads you to expect some nice advantages.

Bob Carver just brought out a great new sub-woofer. Unfortunately, it requires 2700 watts for full output. But I'm told it sounds really nice.
—RAP

Dear Bob:

Once again, you have hit the nail on the head with your column about smog check—"gross polluters." My wife's VW squareback, vintage 1971, did not quite pass the high-speed test (2500 RPM); it was way below the maxim allowable at idle. It was promptly dubbed a gross polluter requiring her to leave the car with an expert mechanic, who tried various rebuilt computers (new ones aren't available any longer), as well as new pressure sensors.

After screwing around with these devices for a whole week, he finally found a computer and pressure sensor combination that allowed the car to pass. However, we are now \$850 out of pocket, and still have to take the car to a so-called "referee" station to have its good name cleared in Sacramento.

Why isn't similar criteria applied to trucks, busses (especially school busses), and motorcycles with and without mufflers? They stink up the environment at least as much as the cars. I believe that there is, indeed, a conspiracy to remove older cars from the road. Could it be so that the dealers can sell more new cars? Of course not, they would never pull such a dirty trick!

GERARD L. ZOMBER

Venice, Calif.

As I said, if it's really hard to get to your car to pass smog, then sell it out of state and buy something that's easy to keep tuned. Now, the Feds do want to crack down on particulates (diesel smoke, etc.). And a lot of people are bleating this will be very expensive, NOT cost-effective for improving health or air quality. Who's right? We shall see. —RAP

All for now. / Comments invited!
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What's All This Puzzle Stuff, Anyhow?

Well, April has rolled around again—and that means one thing: 'Tis the season to raise questions. Answers will come in the next issue.

1. Little Egbert has some long, rigid cylinders—a whole lot of them. He observes that he can arrange 2 of them to touch, and, of course, he can arrange 3 to touch each other. If he stands one on end, he can make 4 cylinders each touch each other one. How long can he go on with this? Can he get 5, 6, 7, 8, or 9 cylinders to each touch each other? Of course, bending, warping, or deforming the cylinders is not permitted.

2. In the above problem, it is safe to assume there is a solution. In that solution, how long do the cylinders have to be—what is the minimum ratio of L/D? (For $n = 4$, $L/D = 0$, but that's trivial...)

3. What is it, that is Greater than God, and Worse than the Devil, and if you eat it you will die? (Hint: This riddle is probably at least several hundred years old.)

4. Take a doughnut. Or a bagel. Or any toroid. Cut it with a straight (planar) cut. Do not rearrange the pieces. Cut again. Then cut a third planar cut. How many pieces can

you cut the toroid into? Note, a doughnut really is DIFFERENT from a biscuit (8 pieces max)! However, in this case, it makes no difference if you use a SOLID toroid, or

just a SHELL. The answer is the same.

5. The same problem as above, but, you are permitted to rearrange the pieces before you re-cut. How many pieces can you get with 3 cuts?

6. What is it that God has none of, the Queen of England has very few of, and I have lots of? Note: This riddle is probably not half as old as number 3.

7. A cowboy rode into town on Friday. Four days later, he rode out on Friday. How did he do that?

8. A cowboy rode into town on Thursday October 4. In less than a year, he rode out of town on Thursday October 21. How did he do that?

9. What two MAKES of automobiles can have their names turned into another MAKE of automobile by adding one letter and rearranging the letters?

10. Can you take a piece of paper and fold it over (fold it in half) 10 times? Here's a \$10 bill. If you can fold it in half 10 times in a row (and not unfold it each time), you get the \$10. If you can't, you owe me \$10. Now, are you having trouble folding it in half 10 times? I can fold a piece of paper in half (repeatedly) up to 10 times. How come??

11. Extra credit: Here is the answer to a question—*aggry* (a Ghanian burial bead) and *puggry* (a scarf worn under a hat, to protect the back of the neck, in India). NOW—what is the QUESTION? This is a trick question; don't feel bad if you can't guess.

All for now. / Comments invited!
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What's All This Solution Stuff, Anyhow?

Here are the solutions to last issue's puzzles: Of course, to post these *solutions* just two weeks after the questions, we had to print them before we saw any readers' answers. Thus any superior or amazing solutions sent in by readers will be mentioned in a couple months....

1. Little Egbert can arrange all 7 cylinders to touch each other—3 on a bottom deck, and 3 above them on a higher, parallel plane, and one down the middle (*Fig. 1*). I can't prove that you can't do more than 7, but it looks convincing that you could never add one more to this arrangement and have it touch all the others. Conversely, I cannot think of any solutions for 5 or 6 cylinders that are not trivial variations on this. If you can get past 4, 7 is easy.

2. The minimum length is a bit less than $6.1 \times D$. The numerical answer is approximately $6.062178109 \times D$, give or take a few ppb. The first approximate answer is that the angle x is: $x = 49.1066^\circ = \tan^{-1} 2/\sqrt{3}$. We can then solve for the length L by the law of sines:

$$L / \sin 60^\circ = 3\sqrt{3} / \sin (120^\circ - 2x).$$

But by using the formula for the $\sin(a-b)$:

$$\sin(a-2x) = \sin a \cos 2x - \cos a \sin 2x,$$

and also the identity that $\sin 2x$

$$= 2 \sin x \cos x,$$

and starting from: $\sin x = (2/\sqrt{7})$ you come up with the precise answer that $L/D = 3.5\sqrt{3}$, which comes out to the numerical answer listed above.

3. What is it, that is greater than



BOB PEASE

OBTAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

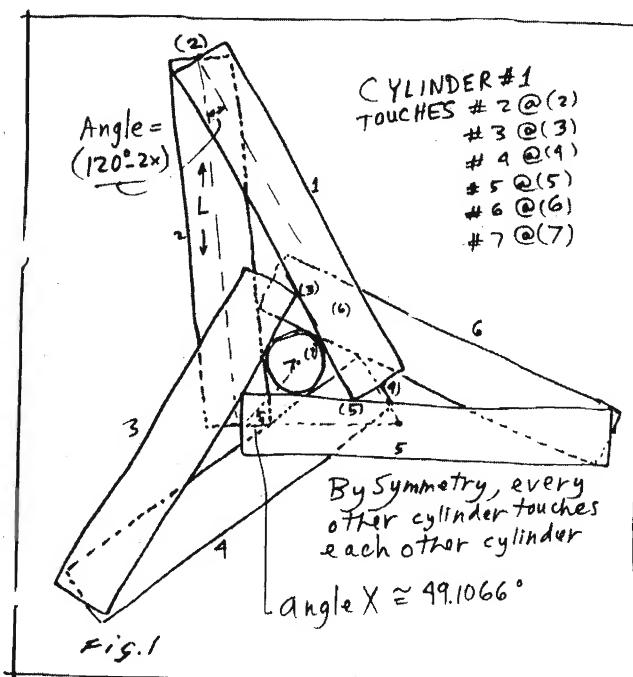
$L / \sin 60^\circ = 3\sqrt{3} / \sin (120^\circ - 2x)$. But by using the formula for the $\sin(a-b)$:

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$$= 2 \sin x \cos x,$$

and starting from: $\sin x = (2/\sqrt{7})$ you come up with the precise answer that $L/D = 3.5\sqrt{3}$, which comes out to the numerical answer listed above.

3. What is it, that is greater than



God, worse than the Devil, and if you eat it you will die? NOTHING. One guy told me, "I ate nothing for breakfast. Am I going to die?" I replied, well, yes, sooner or later....

4. You can cut a doughnut into 13 pieces with three cuts. The first two cuts are fairly obvious, each slicing along the axis through the North Pole and the South Pole (*Fig. 2*). A 90-degree angle looks nice, but any angle will do. Now, with the third cut, can you cut each of the 6 pieces into 2 pieces? Yes, and you can even cut one piece into 3 pieces, as shown. Cut through the axis at point X, and you'll get 7 more pieces. Admittedly, a couple of the pieces are pretty small.

5. By cutting at MMMM, and then at NNNNNNNN, you get 6 pieces. Now arrange the pieces as if on one flat plane, and cut carefully as shown (P-P), and you get 18 pieces (*Fig. 3*). I had a solution with 14 pieces, but Jim

Ball over in our Input Signal Group came up with this excellent and cagey solution. Some of these pieces are pretty *small*, too. Note, I drew this with a skinny toroid. It would work with *any* toroid, but the *drawings* would get too bulky if I did these cuts on the fat toroid shown in item 4.

6. The guy who sent us this riddle back in 1991, Steve Aisthorpe, just happened to depart from our trek around Mont Blanc, before we remembered to ask him to tell us the answer. So I kept racking my brain.

Sins?? Chest hairs?? I was sitting on a stone wall in Dhara-paani, Nepal, last March, 40 miles from the nearest road and 20 miles south of Dhaulagiri. I was resting and dangling my feet, when along came Steve! He was doing missionary work in that area. He finally told us the answer: PEERS. Good answer! It sure was good to see Steve after

five years. Actually, he told us the riddle in part 3, above, too.

7. The cowboy's horse was named Friday. (Shamelessly lifted from *CarTalk*.)

8. On October 4, 1582, THURSDAY, that was the last day of the old Julian Calendar. That was the day the cowboy rode into town. The very next day was Friday, October 15, 1582, which was the first day of the Gregorian calendar, which we still use. Six days later, it was Thursday, October 21, and the cowboy rode out of town. (NOT stolen from *CarTalk*.)

9. If you add a K to the letters in ISUZU, you can spell SUZUKI. If you add a V to the letters in DATSUN, and rearrange thoughtfully, you can spell SATURN.

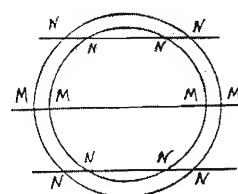
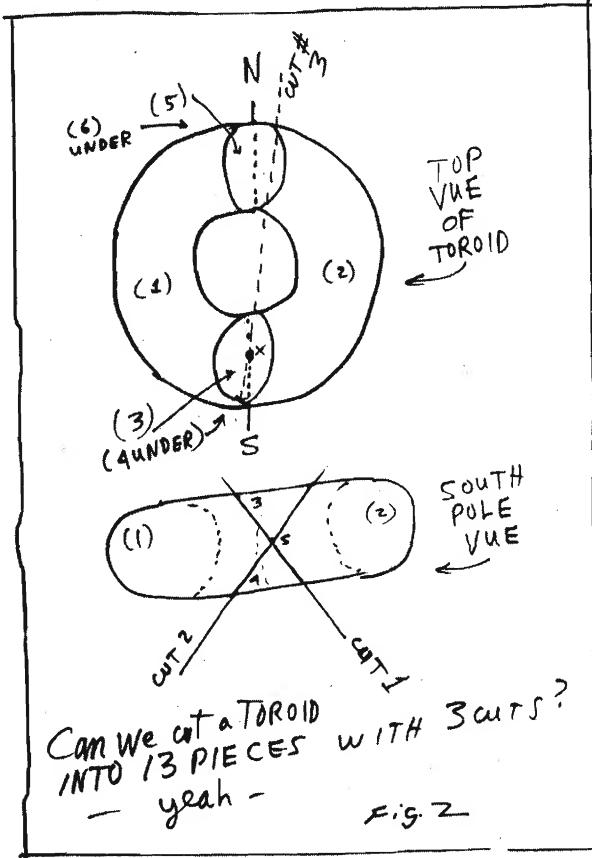
10. Think about the status of the piece of paper that has been folded 9 times, just before the 10th fold. You have something as thick as a big tele-

phone book, over an inch thick (even if you used very thin paper). It's kinda hard to fold it again—you certainly can't do that with a \$10 bill. So, you lose. I, however, started with a piece of paper 100-feet long by 8.5-inches wide, from an old copy machine that used roll paper. I folded it 3 times to be 1-inch wide. Then I folded it 7 more times. It came out 5-in. thick—and barely 4-in. long—with a huge folded area. But if I had a big paper punch, I could have punched 1024 little paper circles... in concept.

11. Extra Credit: If the answer was "aggy and puggy"—What was the question? This: "There are 3 common, everyday words that end in 'gry'.

One is *angry* and the other is *hungry*. What is the third word? We use it every day, though we do not think about it." As you may have noticed, the aggy (Ghanian burial bead) and puggy (alternate spelling of puggaree or puggharee, a scarf for the back of your neck in India) are NOT EXACTLY "common, everyday words." So let's lay that one to rest. When this question was passed around by word-of-mouth by teachers and students in school, and

on the Internet, we trusted that it was a valid riddle, with a real answer. People who lay out trivial riddles that have no real answer, are NOT nice people. Not helpful. They make me *angry*. Life is full enough of tough questions that have tough answers, not to try to fool us with impossible questions.... Heck, this is just another way to use the Internet to waste time. The story I heard about the origin of this riddle was that a kid supposedly wanted us to think



If you Rearrange the Pieces after each cut, can you cut a TOROID into more than 13 pieces?
YES - 18.
FIG. 3

about *gravity*, but misstated the question. Yeah, sure.

Lastly—This is not a *riddle*, but a challenge appropriate for this time of year: can you bend some solder so it looks just like a paper clip? I'm pretty good with pliers, and I am pretty good at manipulating wire, but this is harder than it looks. Yet if you get some good results, you can puzzle the heck out of some secretaries. If you succeed, don't mail it to me, as it will croak in the mail. But if you photocopy four paper clips and four fakes, can I tell which is which? I made a few paper clips out of solder, indentations and all. Not worth the effort. Besides, they do not sit up in a magnetic paper-clip holder.

P.S. Take a peek at my new website: <http://www.national.com/design>, and hit "Good Stuff"—RAP

BOB'S MAILBOX

Dear Mr. Pease:

You write like some of my best teachers taught. Theory is fine, but experience passed on is crucial. I repair a lot of pc boards, most of which come from computers/electronic systems in machine shops. Some of this technology literally goes back to the late 1960's and earlier. Some parts are difficult to find, so we sometimes substitute a newer, more-reliable component. We look for old data books and hang on to them to identify said old chips so we can test them. Imagine my surprise, therefore when I looked in the *National Semiconductor 1982 Linear Databook*. It officially describes your LH0033 and LH0063 as *Fast and Damn Fast Buffer Amplifiers*. 'Fess up, Bob. You wrote these, didn't you?

MATT J. McCULLAR

Arlington, Texas.

No, I didn't write those; they were done before I came to NSC in '76. About 1985, some born-again Christian wrote to Charlie Sporck and asked him why he couldn't delete the naughty word. He couldn't think of a good reason to argue.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

Bob's Mailbox

Hi, Bob:

Your column about teamwork inspired me. This letter is about impedance matching, or maybe architecture....

Pat's Rule #1: Teams must "happen," they can be guided but they cannot be *forced* to occur. Very nonlinear.

If we gather the right cohort, the result is almost magical. But the wrong cohort is just a "group;" a team that didn't "jell." It will generate tremendous internal strife and small results; entropy at its finest.

The business community's present approach to teamwork treats everyone like gas molecules: Put enough of them together and maybe "the magic" will happen. It's seeking critical mass but it's getting liquefied employees. *And it doesn't know why.*

Scientific method is supposed to begin with observation, then proceed to hypothesis and testing. Unfortunately, lots of folks skip the observation and proceed directly to the testing. They'd do well to fall back a bit....

Consider groups that occur in nature, like animal packs. Dogs and humans are much alike, so they are a good candidate. Every pack has a leader, an "alpha." No pack has two alpha members for very long; one will be driven away; the remaining members will be subservient. And they will form an effective internal "pecking order."

A pack with small internal strife is a very effective organism. In fact, it's so effective that we humans have laws to protect us from it. Unfortunately, we humans also fancy ourselves "superior" to other animals, so we form our packs arbitrarily, then wonder why they fail.

And we generate endless discussions about the "qualities of leadership" then jam the boss's kid into the alpha position even though he or she has a naturally subservient personality (relative to other members of the pack).

Pat's Rule #2: Employees are valuable because if you add one, or take one away, you change the entire nature of the pack. Major transfer function revision. Not necessarily bad, but



way different!

I don't talk much about this stuff because the people around me generally don't like to picture themselves accordingly. But I do use it as a gauge, especially when I'm seeking an impedance match with a new customer (internal or external). I think of it as the "personality domain."

I look for the "alphas;" the movers and shakers in their organization. And I try to identify the "doers" as well. Each is useful; each is necessary; each can help my company thrive, even if they don't (or cannot) explicitly recognize their own roles.

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PAT BARRETT, PE
Barrett & Associates Engineering
Portland, Ore.

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RAP / Robert A. Pease / Engineer

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What's All This Web Stuff, Anyhow?

Once upon a time, the world was a simpler place. There was no Internet; there were no Web Pages. While I am in favor of simplicity, I will not argue that we should (necessarily) all go back to a simpler age. But there certainly are some amazing things going on—and not all very useful or good.

YES, I do have a website. You could look it up yourself if you go to: <http://www.national.com/design>. My home page there is cleverly hidden as "good stuff." The actual site is <http://www.national.com/rap>. There are about 7 categories of good stuff there. More later.

My first interaction with the Web was about a year ago, when my column on "Speaker Cable Stuff" had just come out. One of my friends



BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

At that point, I tried to figure out why he thought it was so funny.

He claimed that since I had said that you could make a low impedance cable by connecting several cables IN PARALLEL to drive from an

amplifier to a load, such as a speaker, I was stupid and full of baloney. He observed that if you parallel several cables, you do not get a low impedance cable, you just get a disastrous and impossible-to-analyze mess.

I tried writing to this guy. I tried to explain that if you have one signal driving through a length of coax cable (such as 50- Ω cable) into a resistive load (such as 40 or 50 or 60 Ω), then you can easily make a reasonable estimate of what will happen at the far end. Now, if you have (for example) 10 such coax cables, each independently driving a resistive load, the voltages will not change. THEN if you tie together the far ends of the ten 50- Ω cables each driving a resistive load—such as ten 50- Ω loads—still, nothing changes. The voltage response remains the same, but the cable's impedance IS effectively 5 Ω , and it's good for driving a 5- Ω load. It is NOT hard to analyze, not a mess. So, paralleling several cables to form a low-impedance cable that can drive a low-impedance load, with low phase shift and low reflections, is NOT an insane exercise, but actually a fairly simple, high-performance circuit to analyze—by symmetry.

I sent a note of explanation to the "ROTFL" guy. He never replied. He never gave any acknowledgement that I had a valid answer. So, if that is the way that the Internet works, then I am not impressed that this is a fair game.... people "flame" you with no provocation, and there's almost no defense against it. But, what did you expect in a domain where most of the information is HaTeMail?

I've looked at several good websites, and a few dozen mediocre ones, and some bad ones. I went to the "useless" site: <http://www.go2net.com/internet/useless>, and checked out a few of their "useless" websites. Yeah, there sure is a lot of useless information. For

example, I am amused by the story of the coffeepot at CERN in Geneva Switzerland, that has its own website: <http://www.cl.cam.ac.uk/coffee/coffee.html>. If you work at CERN and you want to know if there's enough coffee in the pot to justify a long walk to the coffee room, then for you, it's useful, because you can see if the pot is full. For everybody else, useless. A friend urged me to look at the images from the Slug Video Camera at the Dream Inn from the Image Processing Lab at University of California, Santa Cruz: <http://sapphire.cse.ucsc.edu/SlugVideo/dream-inn.html>.

Impressive, but not very useful. If you tell me about INTERESTING websites, I'll be interested.

I tried to access a site for old orphan computers, as mentioned in a letter we published in *Electronic Design* a few months back. Apparently that site was discontinued, but Brian Mork found the new location, at: <http://www.pas.rochester.edu/~tgpt/orphan>. They discuss several kinds of obsolete computers, but not the Tandy Model 102 or the ADAM.

On the other hand, there are some new sites that are virtually impossible to access. Some of the Anglophiles in our neighbourhood recommended the new site of the Queen of England at <http://www.royal.gov.uk>. I tried 10 times. I even tried at midnight when one would not expect them to be "too busy." I never did get in until I tried at 2:15 a.m. The site was very stately and classy—as you would expect.

But Pease, why are you wasting your time looking for the little mouse under the Queen's chair? Personal waste of the company's computer time? Not really. If I find something done nicely or properly, it may be useful in my next website. On the other hand, if I find annoying or objectionable features, I'll try to avoid them. If I find obsolete, out-of-date, or out-of-order sites—of which there are many—I'll try to learn from the experience.

I've checked out a few other good sites, and I'd like to mention them here. If you are interested in some vigorous hiking or trekking in Nepal, check out Peter Owens' site at: <http://www.Instantweb.com/p/peterowens>. It has the same basic information about hikes that you could get by mail, plus extra

information about the travel. And you can easily request detailed info on any particular hike—which will be delivered to you by e-mail. No waste of trees nor postage.

Wilderness Travel in Berkeley has gone online with their own site: <http://www.wildernesstravel.com>. I have not seen it yet, but they are pros in the travel business, and I've enjoyed trekking with them.

I really don't spend too much time at the Doctor Science site at <http://www.drsscience.com>, but I have used the correct form at that site to request a daily hit of humor, which is delivered in my e-mail. I did send a question to the good Doctor:

"Dear Dr. Science: I just got to work and checked out your Questionable Hall of Fame, and at the end, the note said, 'Return Home.' So I did. And now my boss is mad at me. And my wife is mad at me. Why do you send me messages like that, Dr. Science?" Questions like that, I send to drscience@drscience.com.

On a professional note, I can recommend the site of Kimmel-Gerke Associates: <http://www.emiguru.com>. As I say on my lecture tour, "These guys are as good at getting you out of trouble above 1 MHz as I am below 1 MHz."

Similarly, I recommend you take a look at DAC/I Associates: <http://www.cyberspy.com/daci> for worst-case analysis of circuits. They have some good old Design Analysis Newsletters posted, too.

When it comes to product planning and business ideas, I regularly go to John Trudel's website: <http://www.trudelgroup.com>.

Don Lancaster has a lot of good write-ups on the topics of self-publishing and printing-on-demand. And electronics. And he has posted many links to Pseudoscience, Paranormals, and the Skeptics who try to rebut the flakey guys with the bad science. Start in at <http://www.tinaja.com>.

I found a guy promoting his new historical novel on the Web—check it out at <http://www.goodamerican.com>. I don't think I'll buy his book, but I agree that his advertising and promotional tactics make good sense. You can get a free peek at several pages of his book, and see if you want to buy it. I plan to do that with my books.

I have checked out Amazon Books, which has a very broad selection of books and some truly riotous book reviews by readers. Start at:

<http://www.amazon.com>. I recommend the site of Rich Hanson, the purveyor of the venerable Tandy Model 102 Laptop Computers:

<http://www.the-dock.com/club100.html>. Also see the site of the other little Word Processor with 128k of memory: <http://www.alphasmart.com>.

Note to aficionados of guitar folk rock: I have recently become enamored of the sounds of "Babes with Axes," a group of 4 women who play guitars and sing and write their own songs. Their site has some music samples—not that I can tune in. Their site is at: http://www.efn.org/~gordon_k/babes.shtml.

I am still learning how to navigate on Netscape. I often crash and burn. The computer still gets locked up occasionally. And our Web Expert Gary still gets amazed at the way I get into trouble. When some guys wrote me messages at my website's response page, I tried reading some of them, and each message consisted of the first half of one message *and* the last half of the previous message. He had never seen that before. Fortunately, the next day, the problem went away.

One day, all my bookmarks went away. The next day, they all came back. Gary agrees that sometimes, the computer just doesn't seem to like me. It can tell who is sitting in front of it, and it does nasty things just because it knows it's me. Meanwhile, I keep threatening it, if it doesn't behave, I'm gonna throw it off the roof. If I hadn't just paid my tax bill, I could write a check and buy this insolent workstation—and throw it off the roof....

There are still all sorts of amazing things out there in "cyberspace," and some of them come and camp on your doorstep. One guy sent me a picture of a computer that caught fire. Since I didn't know what it looked like before it caught fire, it wasn't very educational. I could not guess why or how it caught fire. But it took me several minutes to erase the picture—all 17,000 lines.

Back on the subject of *my* website. What's in it? A good set of recent columns. So, if you need to look up a recent column, we'll try to keep a good set posted. We're still working on that.

We have 18 columns in there, but we are not caught up yet. There's also a set of older applications information that have NOT been published recently. The first one was a good set of info on the Dielectric Absorption (or "soakage") of capacitors that was first printed in 1982. Several people have already said that they found it useful. The next is a reprint from *IEEE Micro Magazine*: "Third Thoughts on Fuzzy Logic." I confirmed several old opinions, and made some new positive observations. I'll print more stuff there. There is a link to my lecture: <http://www.national.com/events/peasetour.html>—and it is complete with a list of the topics I am likely to be discussing, and the form to use to sign up for the lectures.

There's a link to *Electronic Design* at <http://www.penton.com/ed>. Several people have pointed out to me that it had a neat page that you could use to sign up for a free subscription to the magazine. When you're all done, you looked for the link to hit to send it. There wasn't any!! You were supposed to print out this form and mail it or fax it in. Fortunately, this is being fixed. But when I mentioned this situation at my lectures, it always got a good laugh! There are a few "horrible" pictures. I'll have to add more.

There's a page that makes it very easy to send e-mail to me: rap@webteam.nsc.com. (I probably shouldn't have admitted that, but it's true.)

After I spent a while driving around to various web sites, I began to appreciate more of what Gary had done for me: In a lot of places, when you click on a page, you wait 15 or 25 (or more) seconds, and finally some eye-popping scene pops up. Apparently, a lot of guys think that if you can do snazzy, blinking, bouncing graphics, then you *should*. Yeah, but I find it annoying that so little information wastes so much time. Yeah, I know that "a picture is worth a thousand words." It may cost you 10,000 words worth of information, and when you get it, after a long wait, you discover that you don't want it.

When you hit on *my* home page, the text comes up in about 4 seconds. Then while you are reading the text, about 7 seconds later, the graphics pop up. I like that a lot better than waiting 10 or

PEASE PORRIDGE

BOB PEASE

20 seconds before you can see *anything*. I'm glad Gary did that right.

What else should I put on my website? What do you think? You tell me.

For example, what if I told you that you could get a full 20 seconds of video of RAP throwing 3 computers off a roof?—or a 30-second lecture on op amps?? This would take minutes to get all the bytes into your computer. So, you set the command, and hit the *receive file* button when you leave work at night, and when you get in to work the next morning, the bytes are all ready for you. After all—why should your computer be finished with work just because *you* quit and go home?

What can I say about the Web? It drives me crazy. It's the slowest way to do some things, and a pretty good and quick way to do other things. It's fun and frustrating. It encourages people to send me questions that I cannot answer. But I'm a big boy, and I'm learning to live with that, and I've learned some work-arounds. At first, when I wanted to send a reply to a question, the response got sent—but the person's e-mail address got left off. Not very helpful. *Fortunately*, I did not erase any of the messages before I discovered this. I had to find an alternate *Reader*, so I could read a message and send a note back, and *not* erase the vital information. Never a dull moment!

P.S. I nearly forgot to say this, because it's easy to get enthusiastic about the Web: I forgot to include real phone numbers and real addresses for the companies with the good WEBSITES. Not nice. I really don't like to discriminate against guys who don't go on the Web.

So. (1) If you DO go on the Web, you can look up these addresses and phones in the new section on LISTS.

(2) If you CAN get on e-mail but NOT on the Web, send me a message at *rap@webteam.nsc.com* and I'll e-mail the LIST to you.

(3) If you CAN'T get on e-mail, just mail me a letter, and I'll send you that LIST.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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READER SERVICE 160

Bob's Mailbox

Dear Bob:

I enjoyed reading about your innovative aspirin-triggered moisture detector in the March 3 issue, "What's All This FLOOBYDUST Stuff, Anyhow? (Part 5)." It reminded me of a freezer alarm I built about 20 years ago when my sons were Cub scouts.

The den meetings were held in my basement where the freezer was located. Anyone who has witnessed one of these meetings knows that about 80% of the time is occupied with the boys practicing their wrestling skills. Consequently, in my case, the freezer door would occasionally be left open after impact or the power cord would be jerked out of the wall outlet. I decided to design a cost-effective (cheap, that is) alarm to warn me before the freezer contents had a chance to thaw. No self-respecting engineer would spend \$20 to buy one at the local hardware store.

I used an old copper-clad board that had separated etched pads to which I soldered wires. A 9-V battery and a beeper made up the rest of the circuit. I made a salt-water solution and froze it in a paper cup. Then, the frozen mass was inverted in another cup containing the copper-clad board.

If the temperature rose in the freezer, the mass would begin to melt and drip onto the board, completing the circuit and energizing the beeper. The beeper operated down to about 3 V, and the very-conductive salt water easily provided a low-resistance current path. The other advantage of using salt water is the melting point is well below 0°C, so the beeper sounds before the food thaws. If necessary, the melting point can be accurately set by using a calculated salt concentration.

JACK KNEPLER

*Chief Engineer
BUNN-O-MATIC
Springfield, Ill.*

Hi, Jack, I like your "solution"—elegant. But how do you prove that



the salt water is adequately LOW-Z to ensure the beeper is loud? I guess you just gotta run it!—RAP

Dear Bob:

Regarding the letter from Anonymous in your Dec. 16, 1996 column asking "Why is our profession so poorly regarded?" The answer is in the immortal words of *Pogo*: "We have met the enemy and he is us!"

Unlike lawyers or doctors, no one I know becomes an engineer for the money or prestige. We are engineers because we *enjoy* it. That puts us at a professional disadvantage with our employers and the public.

Additionally, our public relations are very bad. Although engineers have created virtually everything around us in our modern world, no one realizes this. Everyone knows what doctors and lawyers do, and their value to society. But walk down the street and ask someone what an engineer does. You'll probably hear something that relates to Casey Jones.

If we want to change this, we will have to go against our grain and act like the respected professionals do, which I believe means licensing, professional standards with peer review, and self promotion. Of course, this will take all the creativity and fun out of it.

JOSEPH V. D'AIRO

West Islip, N.Y.

Joseph, your comments are astute: Is it worth more to be professional, or to have fun? Or to be able to make a living? No easy answers. One thing Adams' Dilbert has shown: engineers try to make sense, despite their managers' foolish moves.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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READER SERVICE NUMBER 167

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What's All This Tempco Stuff, Anyhow?

In the recent picoammeter circuit I wrote about in the column entitled "What's All This Thermistor Stuff, Anyhow?" (ELECTRONIC DESIGN, Jan. 6, p. 171-172), I showed a circuit for compensating for the tempco of some high-megohm resistors with a fat tempco such as $-250 \text{ ppm}^{\circ}\text{C}$, or larger.

But what if the UNCERTAINTY of that tempco was sloppy, too? What if its tempco was -250 ± 150 ? What if other RN55D resistors added enough slop to the tempco, that it was not performing nearly as well as desired? Well, here's a semi-classical solution—an improvement that needs 2 new trim pots, and a new trim procedure.

The basic circuit (*Fig. 1*) is very similar to the original, except that we have added new components P1, P2,



BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

SOMEWHERE
IN THE MIDDLE, IT WILL BE
JUST RIGHT. So here is the Calibra-
tion Procedure:

- Start at room temperature.

- Put in $I = 0$ and trim P3 for zero output (well below 10 mV).
- Put in $I = -10$ pA, and turn the pot P1 to the LEFT end. Trim P4 to get 1.00 V.
- Keep $I = -10$ pA and turn P1 to the RIGHT end. Trim P2 to get 1.00 V

also.

- Now, repeat the calibration sequence, as there may be minor interactions. When you have it right, turning P1 from end to end will have *no effect*. (This is true because the impedance of the pot P1 is more than 1000 X lower than R_f .)

- Now, put the whole thing in an oven, and allow it to warm up to some suitable temperature in its working range, such as +35 or 40°C.

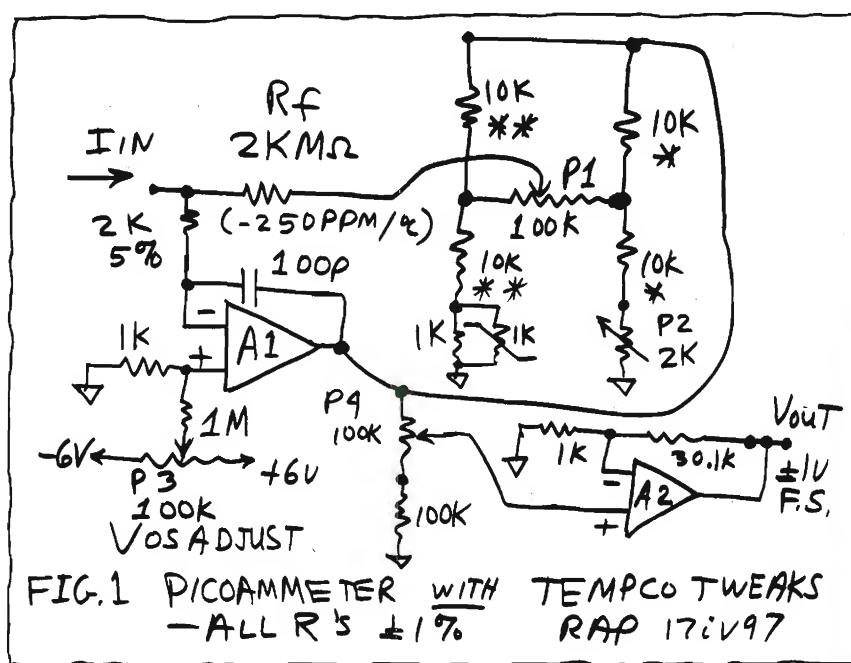
- Put in +10, 0.00, and -10 pA. Before, if you moved the P1 pot from one end to the other, the output stayed at 1.0 V. Now, as you turn the pot, the output voltage goes both above and below 1.0 V. So just reach into the

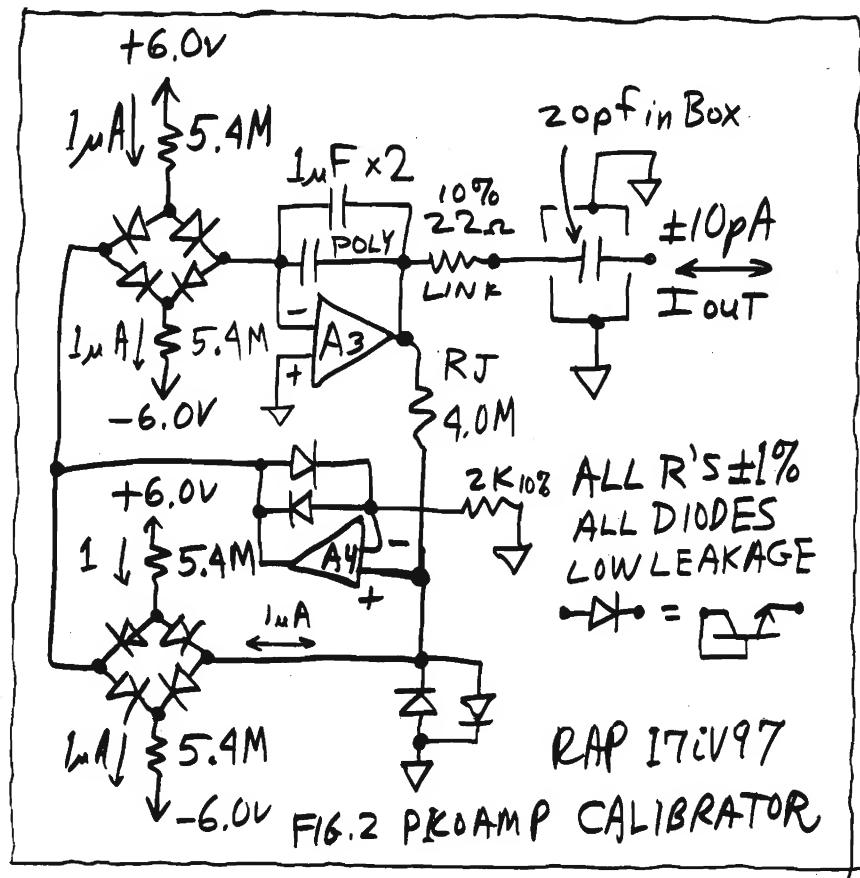
warm oven and trim P1 to get 1.0 V to match the room-temp value. (Better yet, if I_{in} alternates between +10 and -10 pA, trim P1 to get the output voltage to be 2.0 V p-p. This helps to simplify the rejecting of the op amp's V_{os} .)

And how do we generate an accurate, stable ± 10 pA current?? You should refer to *Fig. 2*. A3 is an integrator and A4 is a detector that turns the integrator around when it hits ± 4 V. This is a basic triangle-wave generator that I have been building over the last 30 years. When A4's output is LOW (-1.3 V) A3's output is ramping up at +0.5 V/s. When the integrator gets to +4 V, the $1\ \mu\text{A}$ through R_J just balances the $1\ \mu\text{A}$ coming through the diode bridge, and A4 will switch its output to +1.3 V. The triangle wave changes direction about every 16 seconds. This gives everything time to settle.

The $\pm 1 \mu\text{A}$ coming through the diode bridge into A3 gets integrated nice and slow; it is effectively attenuated by a factor of 100,000—by the ratio of the $2\text{-}\mu\text{F}$ to the 20-pF capacitor—down to $\pm 10 \text{ pA}$. Therefore, as that voltage ramps up and down at $\pm 0.5 \text{ V/s}$, the current through the 20 pF cap is $\pm 10 \text{ pA}$.

It's not hard to measure and confirm the peak + and - voltages at V_j . It's easy to measure the time it takes for each half cycle. As a result, you





can compute the ramp rates easily. The accuracy of this calibration depends on the fact that you can measure a 20-pF capacitance at 1 MHz and its capacitance at 30 milliHertz will be the same. Many capacitors will not do that, but silver-mica is pretty good, and Teflon, NP0 or C0G ceramics are very good: The capacitance does not change much over this wide range of frequencies. Of course, to measure a 20-pF capacitor with 1% accuracy, you will need to mount it securely and stably in a hole in a metal guard wall, and use a meter such as the Boonton Bridge (ELECTRONIC DESIGN, "What's All This Picofarad Stuff, Anyhow?" Jan 22, 1996, p. 99.) I inserted a 22-Ω resistor in the path, to make it easy to disconnect the capacitor from the amplifier for measuring....

Note, almost every 20-pF ceramic capacitor is NP0. You can check that by heating it 100 degrees and watching the capacitance change less than 1/2%. Good stuff!

A3 and A4 can be any op amp with less than 1 nA of input current. Just be sure to use low-leakage diodes,

such as the emitter of a transistor with C and B tied together. Avoid those leaky 1N914s or 1N4148s, as in this kind of circuit, their 20-nA leakage could cause over a percent of error compared to 1 μA.

The actual current fed out of the calibrator to the picoammeter will be:

$$I = C \times (\Delta V / \Delta t)$$

The temperature coefficient of the polypropylene integrating capacitor is down near -200 ppm/°C. The tempco of the NP0 ceramic is ±30 ppm/°C, max. The tempcos of the 4-

**Ya gotta admit, a
"tempco adjust knob"
that has no effect
on room-temp gain
or offset is an
attractive concept!**

MΩ and 5.4-MΩ resistances will all track if they are made out of a lot of 1-MΩ 1% resistors. The tempco of the 1 μA currents will be about +300 ppm/°C, due to the tempco of the diodes, which adds to the -200 ppm of the Poly to cause the dV/dt to increase at about +500 ppm/°C. Thus, the calibrator should be used in an air-conditioned room, unless you wanted to use a trick circuit for the 1-μA current sources.

I showed this improved temp-compensated picoammeter to the guy in South Africa who was originally trying to get good tempco despite imperfect parts. He thought about it. He tried it. He decided it was worth doing. The added complexity of adding 2 pots and a trim cycle in a warm oven was worth it, compared to the uncertainty of the tempco of your whole *instrument* if you didn't.

I also showed this to Ed Walker at Daci: <http://www.cyberspy/daci>. He had suspected my original circuit could lose accuracy if the conspiracy of all the resistors' tempcos ganged up to hurt you. I pointed out to him that this trim scheme would compensate out the tempco of every resistor in the gain path. It didn't really matter if some of the gain resistors were + or -50 ppm/°C. Ed did some analysis and indicated that if all the resistors were at ±100 ppm/°C, in the *worst possible directions*, you might run out of trim range. I agreed that it was possible—but unlikely. So, while my original circuit did make some good *nominal* improvements, and could also cancel out any *consistent* tempco trends of the main feedback R, this improved circuit could fix almost *any* tempco, even if the tempcos moved around considerably. Even if the tempco of some resistors has a little curvature, this does a pretty good job fixing it. Ya gotta admit, a "tempco adjust knob" that has no effect on room-temp gain or offset is an attractive concept!

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

Bob's Mailbox

Dear Bob:

Regarding the letter in the April 14 column mentioning the Damn Fast Amplifiers: Credit for that rightfully belongs to Mike Scott, who at that time, was the Hybrid marketing department. Barry Siegal (now of Elantec) may have had some involvement, too. Mike slipped the title change in during (or maybe after) the final review process of the databook. So, the first time most people saw it was in the final printed copy. There was nothing that could have been done about it at that point, and it seemed pointless to even change it in the databooks. So, it ran that way through most of the decade of the 1970s.

Mike tried at one point to label the LM110 as a "Half-Fast Buffer amplifier" to sort of tie the buffer family together. But, I guess he got caught before that one got to print. Of course, we build the same parts over here at Maxim, but we call them "VERY fast buffer amplifiers."

I'd like to see you do a column on little goodies hidden in data sheets. As an example, my little graph on the LH0023 data sheet of the 1970s: There's a log-log graph to allow you to convert frequency in cycles per second, to frequency in Hertz (it's VERY linear). Another of my favorites was by Dave Fullagar on the Intersil ICH8510 (of about the same vintage) which has a footnote reading: "This product contains Beryllia. If used in an application where the package integrity may be breached and the internal parts crushed or machined, avoid inhalation of the dust." I wish I could come up with an example from Maxim, but I don't know of any. Our publications department is very thorough. Keep up the good work!

BOB UNDERWOOD

Maxim Integrated Products
(National 1971-1983)
via e-mail

Bob, thanks for telling us how things got to be the way they are. I worked on a few data sheets with weird curves.



There was a temp sensor with "Time Constant in Stirred Oil" and "Time Constant in Stirred Pizza." But that curve never made it to print. There was an LM109A data sheet with a curve of "Delivery Time vs. Price." The delivery time was BIG on cheap ones, but SMALL on expensive ones—Sort of like your curve of Hz vs. cps. As for cautionary notes, I like the sign at a ski area: "Do not cross this line. Danger, CLIFFS. Crossing this line could result in DEATH and/or loss of lift ticket."—RAP

Dear Mr. Pease

I just read your May 12 column ("What's All This Web Stuff Anyhow," p. 131), and was interested to notice the bit about the prat who commented about speaker cables. Being in the lighting side of the entertainment industry, I have found many sound people to be very obnoxious. This also means they are very easy to wind up, and are ripe for some serious technobabble. A few years ago, I got involved in a conversation about solid vs. stranded speaker cable. The argument was based on the premise that solid cable is clearer than stranded, but the guy was unable to explain the reason why. Considering once you get to a few thousands watts of PA, both the flexibility and weight of the cables become serious issues. I could not help but jump in on the side of the solid cable, based on the possibility of hundreds of sound engineers struggling to unwind hundreds of feet of the stuff!

Don't ask me how, but I managed to come up with the argument that as current flowed down each and every conductor, the hundreds of smaller strands all produced slightly different phase shifts, thus reducing the clarity of the signal. This was so well received that it was the source of many late-night tour-bus conversations, with half the sound crew terrified about the possibility, and the other half fascinated by the theory.

I still hear the theory quoted back to

me, many years later, normally by someone new to the business. I have no idea whether it has any strength as a theory. But I am sure my ears can't tell the difference. And given the wavelengths we are talking about, anyone who can is probably an alien anyway!

MARCO VAN BEEK

*Vari-Lite Europe Ltd.
London, U.K.*

Ah—so you are one of the troublemakers who helped cook up some of the techno-babble in the first place... I love it! We sure seem to agree about some of the foolish ideas about speaker cables. And just to make sure, I sent you a copy of my column on cables, which you seem to have missed. But if stranded wire is supposed to be worse, why do many experts think that Litz wire is the best? Ah, since nobody can hear the difference, it's just a funny joke!!—RAP

Dear Bob:

I am a reader of yours and I have a question that I would like you to tackle. What is meant by the term "world-class?" Managers will sometimes talk about having built a "world-class" product or a "world-class" organization. I have no idea what it means. The way it is used implies something good, but is it?

J. E. MUSE
*Senior Engineer
Deere & Co.
via e-mail*

Most things that are claimed to be "world-class" are subjective—so it's largely a matter of judgement. But I think any "world-class" subject is just allegedly excellent, up in the top 1 or 2 percentile of such things, or within striking distance of such excellence. Still—it's always a matter of judgement—or you might admit it is a matter of "opinion." Right? And then I found a BIG new Random House Dictionary that defines: "Among the world's best—outstanding." Like, "the cow was outstanding in her field." —RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

What's All This Trekking Stuff, Anyhow?

After all, here I sit, week after week, at this crummy cluttered card table with the computer on it...typing away.... Typing and typing away. Typing and typing away.

Evening after evening. Morning after morning. Right inside the city limits of San Francisco, Calif., USA. Typing and typing away. Typing and typing away. Typing and typing away. Typing and typing away. Is this getting boring, or what?

BUT: I just began—slowly—to—appreciate: For the last month, just above my computer screen, I have been staring at a calendar photo of hikers on the shallow snow fields on Thorong La, the 17,770-foot pass that lets you get to Muktinath, on the Annapurna Circuit. (Copy of this picture available on request.) I began thinking:



BOB PEASE

OBTAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

to do, per day. (At least, on MOST days.) Not a factor of 100 or 1000 or even 10,000 in terms of danger to you getting home alive in good health. (That's RAP's estimate.)

Hey, guys, are any of you good Hik-

ers? Let's plan to take a little hike around Annapurna. We would start from near Pokhara, 90 miles west of Kathmandu, Nepal. We would circle around to the east and to the north, and hike up around the north side of Annapurna in the valley of the Marsyangdi Khola (that's *River*) up to a high camp at 14,000 feet. Then, we would ascend Thorong La (Thorong Pass, as the Nepalese word for pass is *La*, as in Shangri *La*) at 17,770 feet of elevation. This is documented at: <http://www.InstantWeb.com/p/peterowens>

Look up trek #9711 (Nov. 8 to Dec. 6). Or call one of the phone numbers below. After we descend below Muktinath, we go down through the gorge of the Khali Gandaki, a very deep gorge. Probably the deepest in the world.

Well, let's not be too SILLY: How do you walk up over a 17,770-foot pass? If we JUST plunked you down at 16,000 feet, and asked you to climb up 1000 feet, you might DIE. NO KIDDING. BUT if you walk your way up, WORK your way up, from 4000 feet to 14,000 feet, then—it will probably work just fine. The last time I hiked up to a high camp at 14,600 feet, I had no problem hiking up to 15,100 feet, though of course, I had to take 1 full breath per step. Good exercise. Good conditioning.

What does this cost? Well, after you get to Kathmandu, the listed price for this trek costs about \$1660. Not bad for a 28-day trek (22 days on the trail). To travel to Kathmandu from Los Angeles International Airport (LAX) costs somewhere around \$1400. To get to LAX, well, that's not a big deal, but most travel agents can get you there from anywhere in the USA for less than \$400. Better yet, call Peter Owens' agent Govind at (800) 223-1813, or at (510) 222-5307. He has the best deals. Therefore, this

is really NOT an outrageously expensive trek.

When they talk about "you can climb Everest for \$60,000..."—that would be cheap, presuming you come back alive. If you come on this trek, it will cost much less than 1/15 of that. Even if you buy as many rugs as you can carry to the plane. Even if you brought \$200 worth of Nepalese rupees along on the trek. Even if you buy a beer or two every night, it will not deplete all your rupees.

Some treks are listed as "easy." This trek is not "easy." It will be a good tough trek—*goood* hard hiking—with some easy days.

Am I on the take? Will I get a free hike from this? Nope. In fact, if my recommendation causes there to be more people on this hike than otherwise, the first thing is, every hiker gets a cut in price from \$1660 to \$1430; see the web site for discounts. I know Peter, and if he tried to bribe me with a freebie for getting his hike full, I'd take any offer and share it with all you hikers. OK? Right now there are about 5 hikers signed up, with room for 10 more.

Besides, Peter is up at Gokyo Lakes, and since I only recently came up with this plan last night when I had been drinking a lot of red wine—obviously, I have not been in touch with Peter. So this is all a spur-of-the-moment trip. Let's do it.

I bet I can even get my wife to agree to go. She's a good sport. And a good hiker. Yeah, Nancy said she will come, too. This will be her third trek to Nepal in 3 years. She's a stronger hiker than I am. Women hikers enjoy these treks, too.

The only questions are: Are you a good strong hiker? Do you have \$3600? Can you save up 4 weeks of vacation? Let's do it! (Plenty of time to get your passport, visa, and hiking permit.)

How do you find out if you are in shape for this trek? You should be hiking every week, several miles, at a crisp rate. Good hiking. More on this later. Send me a note or an e-mail, and I can help you figure out how to convince you that you are fit.

To read more *detailed* info about trek # 9711—hit the web site listed above, or send a request by e-mail to: treks92646@aol.com, or telephone your request to one of the numbers above. Read about this trip. Even if

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you do not have the money or the spare time to come along this year—I want you to put the bug in your ear. If you are a good hiker, you'll want to come to Nepal someday. Let's see. It's about 8000 miles to Nepal. If there were a bridge across from Alaska to Russia, would I drive there? Yeah, I'd fill up my van with friends and drive over every few years. Since there's no bridge, well, flying is a good way to get there. Saves time.

NOTE: I figured some of this out gradually. While out lecturing, I discovered that if I invited some people to lunch, they would begin heckling me while we were eating. I was really impressed. Hey—heckling Bob Pease has turned into a Cottage Industry!!!

Would I invite somebody, whether or not he or she was an engineer, to come on such a hard-working, 22-day hike, and heckle Bob Pease any or every day? Of course I would. But, to get the best results, that person should be a good hiker. We did this once, 8 years ago, when Bert and Anne Raphael invited us to join them on a trek to the Langtang Valley of Nepal. He told us we would like it. We went, and we were *hooked* on Nepal.

But on the other hand, my wife has put up with me for more than 22 days. A lot more than 22 days... more than 22 years... and she is a good hiker. Since Bert and Anne heckled me and my wife properly, and asked, "Why don't you come take a hike with us—in Nepal?"—I figured I would ask you that same question.

NOTE: If you come take a walk with me, obviously there is no liability to RAP nor to *Electronic Design* nor to National Semiconductor if you have problems. There will not be any liability to Peter Owens, as he will ask you to sign a disclaimer, which is not a big deal.

But I have thought about this hike, and if I thought it was dangerous, I wouldn't go. Am I going? Yes. For the third time, I will cheerfully sign off on Peter's disclaimer, and I will cheerfully go. The risks are minor. I have *enjoyed* hiking in Nepal. I think most hikers will.

So why would anybody go hiking in Nepal?? I've got 4 good answers for you:

1. The hiking is very good, and it's on nice and/or interesting trails.

NOTE: A trail in Nepal is not just a pathway for recreational wandering. This is how the local people actually travel around on their business—their everyday business. They WALK. No wheels—except for prayer-wheels beside the trails....

2. The scenery can vary, but it varies from good to excellent. Even when the viewing is *LOUSY*, it is pretty good. Photogenic.

3. The Nepali people are very nice, as people, and also in terms of people-watching.

4. Peter Owens is a good leader. And like all good leaders, he takes really good care of us. And his Sherpas and cooks take good care of us, and feed us well, too. If you consider any of Peter's other hikes in Nepal, rather than this one I want to go on, Peter treats you well, too. You only have to carry a day pack with a parka and your camera or camcorder, and a bottle of filtered water; porters carry all the tents, food, equipment, and cooking gear, and 22 lbs. of your gear. Not bad at all.

By the way, have any of you out there been on Peter Owens' treks? Namaste.*

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@webteam.nsc.com—or:

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

*In Nepal, "Namaste," spoken with hands placed together, is the standard greeting, on the trail or anywhere. It may mean, "I salute you," but in its full form, it says, "The God that is in me salutes the God that is in you." I think that's a nice greeting.—rap

P. S. After I finished banging out this column, I started musing about what would happen if I invited all of my 165,000 closest friends—all you *Electronic Design* readers—and you all decided to come along? There may be a group of 16 hikers on the trail—every 3 minutes—from 6 a.m. to 4 p.m.—for a total of 52 days. Needless to say, it's a sure bet that the Trekking Office would never permit that to happen!!—rap

Bob's Mailbox

Hi, Bob:

I'm reading your Analog Troubleshooting book for the first time, and found a couple of tidbits in it about vibration affecting circuits that really hit home. So I thought you might be interested in a recent experience of mine that was mysterious UNTIL NOW.

Have you seen these electronic heart-rate monitors that use the EKG-type chest straps? The strap transmits a (typically) 5-kHz burst to a receiver in a wrist monitor, or on a treadmill console, etc. A couple of years ago, I was trying to design a receiver circuit for this stuff to add to one of my boards, and the dang thing was very sensitive to vibration.

Isolating the coil from this vibration didn't help, so I concluded that it must be the op amps that were sensitive. (I confess I never DREAMED it might be the resonant capacitor, which now seems like the prime suspect.) Anyway, my boss thought I was nuts, and we gave up and used the receiver module offered by the folks that made the chest straps.

And guess what? Their modules are almost as sensitive to vibration as my circuit was! WE go through trials and tribulations every time one of our customers makes a mechanical change to their machine, trying to isolate the electronics from the high-frequency vibration in the machine.

Now, because of your book, I have some avenues of attack on this problem. Thanks! OK, I have to admit that all this is really still mysterious until I apply these insights and PROVE that I know what's going on.

By the way, I should point out that it was a message posted to an INTERNET NEWSGROUP discussing vibration and capacitors that led me to your book. Now what would be really cool is having some way to ELECTRONICALLY SEARCH your book for key terms (like vibration!).

KEN GOODMAN
via e-mail



Most high-K capacitors are quite sensitive to vibration, especially if they have a lot of dc voltage on them. Maybe in your application mylars would be a lot better. Show me your schematic—and your parts list!—RAP

Greetings RAP:

Twenty two days on the top of the world sounds really exciting. I was born in Bolivia and we also have some mountains in the Andes that are almost scratching the ceiling. The treks I've had there are still so vivid... maybe it has to do with the lack of oxygen to your brain.

I wish I had the time and money to join you. Nine miles a day sounds like a very good paced trek with plenty of time for enjoyment. By the way, have you ever eaten at "Kathmandu West" Restaurant in Sunnyvale?

MARCELLO SALVATIERRA*via e-mail*

Yes, and I can tell you that their curried mushrooms and 7-bean treats are excellent. Actually, I am sure we will hike 12 miles per day, most days, to get ahead of average—leaving space for bad weather. Twelve miles a day ain't bad, when you get an early start—RAP

Hi, Bob:

For a ranchette, I get a circle with a radius of 0.99916 milli-inches. How did you get 0.9983?

CHARLES A. WILSON*via e-mail*

Easy! I screwed up! I forgot to take the square root. You are right, and I'm wrong. You're the first guy to point out this error!—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@webteam.nsc.com—or:

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What's All This International Business Travel Stuff, Anyhow?

Well, a long time ago, I didn't travel much on business. But that was back in '65. Then, Philbrick sent me to California. I rented a '65 Ford (a much bigger boat than I ever drove before) and went to call on some customers—etc., etc. I survived. I enjoyed it. Then in '69, I went to Japan for a couple of weeks. In '70, I went to England and France, then Germany and Canada.

I survived. I enjoyed the travel—in addition to enjoying talking with some VERY interesting customers (or prospective customers) in interesting countries. But I sure was surprised when the German attendees began to KNOCK on their desks! (That's a sign of approval.)

Recently, I have been doing some more travelling, to as many as 10

cities, to places such as Seattle, Dallas, Chicago, Rochester, and Boston. So far, this has been a lot of fun. I've met a lot of nice people, and friends that had GOOD TOUGH questions for me. I may even be able to set up lectures in other U.S. cities to meet other good friends in the East and South.

But I have learned several *caveats* in international business travel. Always keep track of your reservation numbers so nobody can tell you, "You don't have any reservations." And, beware: If you are going to call on a customer who just might happen to be really *unhappy* with your company, because of some

technical or business or delivery problem, then make sure you ask your local sales guys to brief you on questions and problems and potential unhappiness well before you get there. I have learned to take the local country's airline when I go there. Then if the flight is late, the local guys start apologizing to me. (Whereas if I take UA or NW, and the flight is late, for whatever reason, even headwinds, I have to apologize to them.)

I recently read a book written by a guy on his many years of international business travels. Just a slim book, but well worth the price, and good reading. I recall that he was fascinated by the way that turning off one water faucet in a lavatory caused several other faucets to start to flow! A first-class puzzle! I tried to find the book last night by delving down through the top 4 feet of my in-basket, but I couldn't find the book. When he reminds me that I neglected his book, I'll tell you how to buy it.

I will probably be in Brazil as you read this. If your mail queue is very high or long, and you don't get around to reading this until November, I may be stuck in Brazil for *months*. But I'm a big boy, and an experienced traveller. I can live with that. I might even like to spend some cruzeiros there. Hey, Mr. Feynman learned to like Brazil. Now, I gotta give a lecture at WESCON in November (just a couple days before I leave for Nepal) on "International Business Travel for Engineers."

If you have any comments or anecdotes or stories or ideas about such international business travel—amazing things you have learned—or similar—I'd love to hear them before November. Horror stories? Insights? Incites? Send me a letter—or an e-mail.

Lemme tell you an idea I cooked up recently. First, let me mention that I have given my lecture with 402 slides in 3 hours, in 8 or 10 cities. I was even

invited to give a private lecture to a big corporation where 110 guys showed up. But they could only allot me 90 minutes. So I chopped out some of the foils, and gave a basic lecture (with special foils added, to heckle them) in about 95 minutes. How did I do it? Easy—I talked fast. And I asked 'em all to save most of their questions for the end, so they did not count in the 90 minutes. That was probably about 320 foils in 95 minutes. Most people use about 50 or 80 foils for that long of a lecture. Not me. Of course, if you have seen my lecture, you'll know that I have a lot of throw-away foils....

When I go to Brazil, I cannot rush through 400 or 300 foils in 3 hours. If I can do 200, speaking V E R Y S L O W L Y, it will be a miracle. So how do I get my story across?

I got this idea: Subtitles. If a guy knows English pretty well, but his native language is Portuguese, I should show him Portuguese SUBTITLES—just like they do at the opera, when they want to enlighten us—so he will get a quick idea of what I am talking about. NOT just a translation of what the slide says, but an INTERPRETATION of the key words of what I am going to be talking about. Of course I may have to carry 220 foils for me, plus 220 foils for the Spanish audience in Venezuela—plus 220 for the Portuguese audience in Brazil. But I'm a big boy. I'm sure I can carry that in my briefcase.

I'll let you know how this works out with the SUBTITLES. I'll probably write a column after November on the "International Travel" stories. Will I ever run out of good material for a column? Wellit might depend on the interpretation of "good." I might even be able to give a lecture in Kathmandu after I go hiking in Nepal in November. I could use 220 SUBTITLE foils in Nepali. Show Me Where It Says I Can't Do It!

Namaste.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@webteam.nsc.com—or:

Mail Stop D2597A
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Bob's Mailbox

Dear Bob:

What is "World Class" as discussed in the June 23 Bob's Mailbox that arrived today?

Consider Mensa. They recruit from the top 0.5% or so of the smart folks in the world. In the USA that's about a million, give or take a few hundred thousand. Way too many!

Consider pro athletes. Maybe 0.1% as many as those eligible for Mensa, in any particular league. Say a thousand or so. Still too many.

Consider the best of the best. Maybe 1% of any given pro league are recognized as "World Class." So. $0.005 \times 0.001 \times 0.01 = 0.00005\%$ would be a good upper limit.

Therefore, 25 or 30,000 out of the world are candidates for the title "World Class," from which field you get the Olympic Medalists, Nobel Prize winners, self-made billionaires, and engineers who can build an amplifier with a usable seven-decade logarithmic response.

If your product stands out that far, it's World Class. Examples that spring readily to mind are the Model T Ford; the VW Beetle; the DC-3 (C47); the Piper Cub; the IBM electric typewriter; the Tektronix Scope; the H-P Audio Oscillator; the PDP-8; the 741 op amp; the Philbrick Op-Amp Book; the Howland circuit; the 6800 microprocessor; and the Swiss Army knife. Not to mention a whole lot of stuff from L&N, General Radio, and all those other people who meant "0.01% forever" when they said "0.01%" in their spec sheets.

And Jim Williams and Bob Pease, who know what they're talking about.

JIM TAYLOR
via e-mail

Jim: True, there aren't a lot of world class op-amp designers around. There aren't a lot of world-class voltage-regulator designers—or ballet dancers, or crane operators, or wide receivers, or sopranos, or left-handed pitchers. But when you add up ALL the classes of excellent, talented people, there sure are a lot of world-class people. OK?—RAP


Dear Bob:

I've written before to compliment you on your column; I still say it's great, but have another reason to write this time. You always seem to have a lot of practical advice; those cherished gems of wisdom learned from the school of experience. A fellow professor and I were discussing the challenges students face in prototyping their circuit designs. They start with simple series and parallel circuits on the standard white protoboards.

Since such circuits always seem to work well there, they begin to assume that these nice protoboards are useful for all circuits. It's not until they reach RF classes that they learn some of their limitations. Then they learn about options such as vector boards, perf boards, wire wrapping, and soldering over a ground plane. It would be nice if there were some kind of practical guide to the prototyping options, their strengths and weaknesses, etc. With your experience and bent toward the practical, it strikes me that you might know of such a guide, be it an article in a periodical, a manual, a book, or whatever.

I hope you're not overwhelmed by e-mail, and that you'll have a minute to respond to this one.

BARRY LUNT

*Assistant Professor
Electronic Engineering Technology
Brigham Young University
via e-mail*

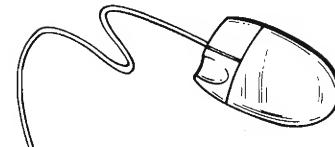
Well, yes, I am real busy, but you are right: Students are not learning about breadboarding skills. How can we encourage them? Technicians and engineers, too. Readers??—RAP.

All for now. / Comments invited!
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What's All This Errata Stuff, Anyhow?

This was GONNA be a Floobydust column, but it turns out that this will be one chock-full of some of RAP's Errors:

(a) I was partly correct when I said that 1 meter was exactly 39.370000 inches, and 1 km = 3280 ft. + 10.000 in. It did *used to be*. That was the statement in my 1958 *CRC Handbook of Chemistry and Physics*. But then they changed it later on in 1958. The U.S. inch was changed by 2 ppm, to exactly 2.540000 cm. The NBS did not ask my permission. The CRC did not recall my book. Hey, it's only an error of 2 ppm. Most people wouldn't notice the difference. But if you were buying a square mile, you wouldn't want to be cheated out of 111 square feet.

About a dozen guys wrote to correct me. They were right. Note: I had

sent the draft of my column, with this old error, to 60 guys within NSC, and none of them noticed my error.

(b) I stated in a recent column on Measurement that a thumbnail was not 1-mm thick. It was, I said, more like 0.5 mm. But one guy spotted

that I multiplied my 12 milli-inches by 39.37 instead of dividing by 39.37. So, it was really more like 0.3 mm. I am usually fairly careful about my

dimensional analysis by saying out loud, "1 inch = 2.54 centimeters = 25.4 millimeters; and one milli-inch is 25.4 micrometers. Then 12 milli-inches is about 12×25.4 micrometers, which is equal to 300 mi-

crometers, or about 0.3 millimeters." But I got sloppy. Dumb error.

(c) Likewise, I said that a Ranchette (which is equal to 0.5 picoacre) was 0.9983 milli-inches in radius. JUST ONE GUY, Charles Wilson, questioned me—he computed 0.99915 mils in radius. He was right. I was wrong. I had neglected to take the square-root. So, one Ranchette is an area equivalent to a circle 0.99915 milli-inches in radius.

(d) Similarly, I explained very plainly and correctly, several months ago, that 9 old copper pennies weighed within 1% of an ounce, but it took 11 new zinc pennies to weigh that much. Yet in the March 3 issue on page 188, I was sloppy and said that 9 new pennies weighed an ounce. WRONG!!!! I sorry!

(e) I stated that you can send only as much as 1.99 pounds of U.S. mail at the first class rate for \$3.00. But Robert Klabis pointed out that if you get an Express Mail Envelope (free at any Post Office) you can fill it up, and mail it for that \$3.00 fee, even if it's over 2 lb. Now, it's hard to squeeze more than 2.5 lb of copy-paper into one of those envelopes. But if you have to send 4 copies of *Electronic Design*, weighing up to 3.5 lb., you can send that for \$3.00. Not too bad, when you consider that a 13-ounce package also goes for that price.

(f) In my recent column on Web Sites, I mentioned the coffeepot at CERN that had its own web page. Two guys wrote in to observe it was NOT at CERN, but at Cambridge University in England. I got fooled by some misleading text in a newspaper story. SORRY!!!

(g) One guy observed that if you use the right interpretation, and if you had some cylinders smaller than others by exactly the right amount, you could get 8 cylinders to "touch" each other. Well, if you go out to "The Four Cor-

ners" area, and you use a definition that Colorado "touches" Arizona (which is diagonally opposite), while Utah "touches" New Mexico, then you would agree that he made 8 cylinders that "touch" each other (*see the figure*). But I don't like that definition—nor that solution. When I get 7 cylinders to "touch," they really TOUCH.

(h) I got some e-mail from a mathematician, Mr. Alan Kaplan, who found it hard to believe that I could cut a torus into 13 pieces. But I talked him into it. Then HE pointed out that if you considered a hollow toroidal shell (instead of just a solid torus), you could cut it into 14 pieces. Well, I found that hard to believe. Think of the piece that's labeled 2 in the April 14 issue. If you consider it as a solid, you can cut that into 3 pieces. But if you consider it as a thin shell, it is now cut into 4 pieces. So, he was right! While many patterns of cuts will make exactly as many pieces of surface as of solid, here's a case where the number is *not* the same. And that is the solution I showed in my Column!

(i) I told some people on my lecture tour that Avogadro's Number had been changed from 6.0228 to 6.047×10^{23} . Everybody was astonished. Why? Well, first I think I must have miscopied the number. Maybe it was changed from 6.02283 to 6.022147. A minor change of perhaps -0.011% . This occurred about 15 years ago, we THINK, and the reason was to base the number on atoms of CARBON (instead of OXYGEN), which could be done more precisely. This may be because carbon does not have as many screwy isotopes as oxygen does. I'm not sure if that makes the number of atoms any easier to count....

(j) I said that a thermal "pilot generator" used in a gas stove must be some funny animal, because it could not be a series connection of several thermocouples. Well, somebody gave me an old "pilot generator." I busted it open. Guess what was inside! A series connection of (N) thermocouples, with about $?\mu\text{V}/^\circ\text{C}$. That's reasonable.

(k) I built my water detector with steel wires pressing on a thin piece of sugar cube. I still have not had any false alarms. (Ants out here don't attack sugar.) But when I put water on it a couple of times, it did not contact really well. So, I took some old gold-plated



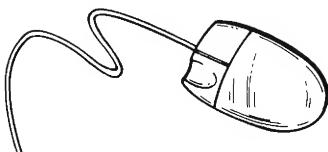
BOB PEASE

OBTAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

dimensional analysis by saying out loud, "1 inch = 2.54 centimeters = 25.4 millimeters; and one milli-inch is 25.4 micrometers. Then 12 milli-inches is about 12×25.4 micrometers, which is equal to 300 mi-

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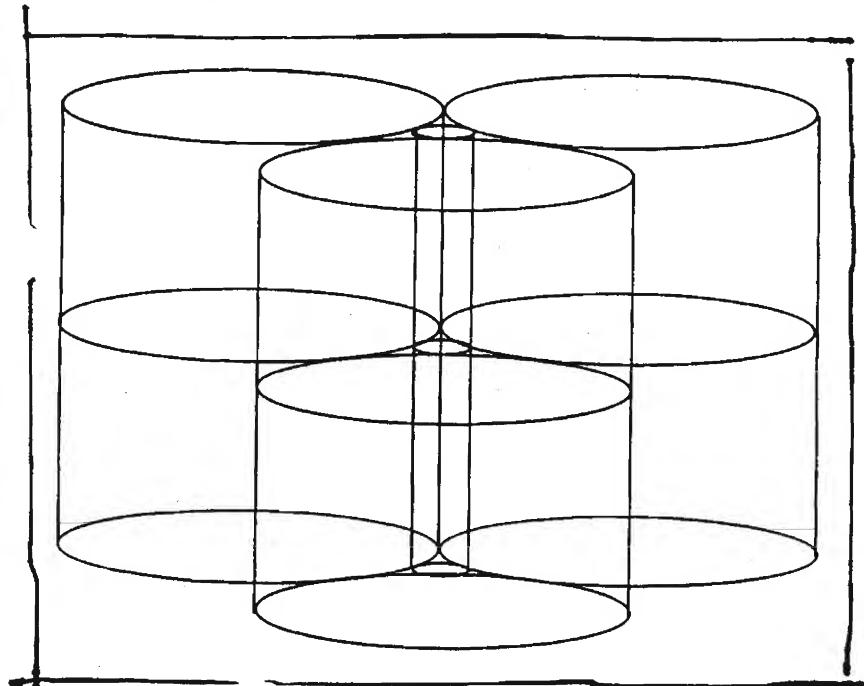
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Submitted by Mike Deering, Sr. Project Engineer, TRW Automotive Electronics, Farmington Hills, Mich.

transistor leads and set them up to act as the contacts off on the side where they never touch the sugar. They seem to be more reliable for contacting. One guy proposed a plastic clothes-pin. That sounds OK, but if you laid it down in an upright way (horizontal pivot), the water would not hit the sugar until it was 1/4-in. deep. Solution is to lay it on its side, with vertical pivot. That would work pretty well—especially if you add gold-plated contacts.

(l) I said the number of miles around the Annapurna Loop was about 205. I got more information from different guidebooks. That old number may have been true before newly constructed roads lopped off 40 miles. Now it's probably more like 166 to 163. Bejruchka's book states that the mileage is "more than 150 miles (330 km)." Well, 330 km equals about 205 miles, so that is probably what it was originally. But in Nepal, they don't usually talk about the *miles* of a trail. They count it by the *hours*. Still, 165-odd miles is not so bad for 22 days. More like 7.5 miles per day, rather than 9.3. Of course, we will take a lot of day hikes after we get to camp.

(m) For years I've remembered that the length of the Harvard Bridge is 364.4 smoots. In June, I walked across the bridge to Cambridge to go to see some guys at Draper Labs. I said I avoided the expense of a cab,

and the JERK on the MBTA trolleys, by walking across the Bridge. They asked me how long the bridge was. I told them how many smoots it was. They said, "AND???. . . ??" and I added—"and one ear." That is the correct length of the bridge. One smoot is about 5 ft 11 in., named for Oliver Smoot (MIT '62) who was laid down end-to-end with himself, 364.4 times, to calibrate the length of the bridge whereby Massachusetts Avenue crosses the Charles River to go to Boston. By forgetting the "one ear," I made an error of the order of 40 ppm. This is perhaps 20X bigger than the error involved in the revision of the meter's calibration vs. the inch. But I just had to include this to heckle Roger Engelke and Mike Sciannamea and make them grouchy. The rachette is not exactly a standard measure of area. But the smoot is well known in Boston and Cambridge Mass. They can both be found in the Webster's Third, Unabridged, International—well, at least in MY copy...

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Bob's Mailbox

Bob:

What are you doing? Your column is normally something I enjoy reading—for electronics-related issues. Even when you go off on a tangent and talk about cars or oven thermostats, at least it's engineering-related. Columns about hiking would include something about batteries and solar power. This trek stuff has nothing even remotely related to the magazine's normal content. I am disappointed that you would use your column (nearly 2 pages) to solicit a vacation trip so you can save a couple of bucks. If I were reading about this in a hiking magazine, I would not feel like I was wasting my time because the article is consistent with the focus of the magazine. Obviously, that isn't the case here.

Don't get me wrong, I like hiking and camping. In fact, I like it very much. There are a lot of things I like to do. What would happen if every writer who has a column in a technical publication decided they wanted to take a vacation and began devoting their entire column to recruiting people for a particular event?

Please go back to what you do best in this field, and post vacation desires somewhere on the net or at local REI stores.

PAUL LEONARD*via e-mail*

Hello Mr. Leonard—you are right. Hiking is a waste of time and energy. Reading about hiking is a waste of time and energy. Going on a BIG trek is a BIG waste of time and energy and money. But it can be INSPIRING. You get YOUR inspiration YOUR way—I'll get mine my way. If reading about that is annoying—then don't read it. But, all work and no play makes Jack a dull boy. (Or Paul.) So—I can't please everybody all the time. I'll be back to write more about electronics. But only after I get inspired.—RAP

P.S. The intent is not to "save a couple bucks"—rather, to lure other engi-



neers/hikers along so they can be inspired, too.

Hi, Bob:

It was with great yearning in the very depths of my soul that I read your July 7 column on Trekking. A soul-cleansing trek in Nepal would once again put my spirit in equilibrium. I want to go. I need to go. I have a passport, I can swing the bread, and I can get the time off. My wife would not stand in my way. All that I need I have—except a working kidney.

Even though I self-dialyze, four weeks of dialysis supplies would more than fill a van. You see what the problem is. So here I am, in my office in Hackensack, N.J. on a rainy summer day, wishing I could go to Nepal, and knowing I can't. I will add this to the list of "I can'ts" that have come up lately. Like "can't change jobs." You can help me, though. I bet you take pretty good pictures. I would be willing to pay for film and developing in return for some prints. If I cannot go for real, perhaps I can go vicariously.

MIKE MCGINN*via e-mail*

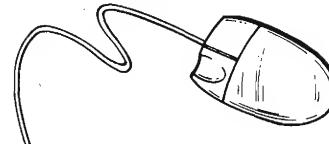
Don't send me any of your money. Just remind me when I get back. I can get you some inspiring photos. We can buy NICE 8-in. x 11-in. prints for about \$3. So—sit on your money. I can make a few extra prints of some very nice scenes—for cheap. Also, be sure to send me your snail-mail address someday. My wife will be taking MOSTLY 35 mm prints, and I'll be making mostly videotape. Better audio that way, I hope. So, I presume you'll like a chunk of video, too. Can do. I'll walk a few miles for you.—RAP

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What's All This Scrooge Stuff, Anyhow?

More than 30 years ago, I began playing this different version of Solitaire. Where did I learn it? At Gardner Perry's house in Acton, Mass. Not just a quiet, thoughtful version, but a breakneck version. I'll write it down here. It's a unique kind of card game, because looking at any card is not cheating—it is permitted. Think about it.

First of all, I will mention that I have always refused to learn to play Bridge—and for a reason: First of all, the rules are quite artificial, and arbitrary, with many kinds of communication forbidden. Second of all: I know a number of guys who flunked out of M.I.T. because they could not resist the call, "We need a fourth! Who will join us to make a game of bridge? Hey, Joe, I don't care if you need to study,

we need a Fourth!" Since a game of Bridge needs 4 players, then a person who knows how to play could be considered anti-social if he refused to join in. That's the main reason why I refused to learn to play. I

should mention that the Game of SCROOGE can be played by any number of players, from 2 or 3 to 4, 5, 6, 7, or more. Seriously, I must admit, a game with 3 players is just *so-so* but 5 is much

busier than 4, and 6 or 7 becomes mind-boggling....

The Game of SCROOGE

Written down by R. A. Pease, 1985, and updated in 1997.



BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

First Description: The game of SCROOGE is a competitive form of double- or multiple-solitaire (see "Conventional Solitaire Play," p. 138).

Object Of The Game: To get rid of all the cards in your SCROOGE pile as fast as possible, while putting as many of your cards as you can out on the Aces in the center of the table.

Philosophy Of The Game: Within certain guidelines listed below, you play as fast as you can, to move cards (legally) out of your SCROOGE pile, and onto the Aces. Also, you play the cards in your HAND to help get cards onto the Aces and out of your SCROOGE pile. Anybody can look at any card at any time. Thus, there is no harm to have cards that are well worn, even ones that are too tattered or bent for any other card game!

Number Of Players: A game of 2 is occasionally boring. A game of 3 is boring, not often. A game with 4 players is very RARELY slow or boring. A game with 5 or 6 or more players is almost never boring, and usually frantic or insane. It may tend to turn into a riot. Generally, quite challenging.

Still, this is not bad as Bridge, where there is only one number (4) that is permitted to play.

Equipment Needed: At least 1 deck of cards for each player, with different CONTRASTING back-patterns or colors; pencil and paper for keeping score; and a big, well-lit table, preferably 40 inches in diameter. (A card-table such as 30-in. square is rather too small for 4 people.)

Types Of Skill Involved: Setting and changing priorities. Watching 15 or 20 things at once (literally). Manipulating variables. Avoiding getting seriously angry, even when sorely provoked. (A nontrivial statement.)

Skill And Practice Level: One of the best aspects of the game of SCROOGE is that kids, young people,

and beginners can play. It is a good, challenging game, and not hopelessly discouraging for kids of all ages, and adults, too.

The SCROOGE PILE: This is a handicap pile. Each player places his SCROOGE PILE at his left, face up, overlapping so he can just see what each card is. (Everybody else can see them, too, and can see what each player's priority is—and how many cards are left.)

The normal SCROOGE PILE is 13 cards. Experts should play with more than 13 cards. Kids who are learning to play can take as low as 10. I know kids who started out at 10, worked their way up to 13, and are now playing at 15. I played at 13, 14, 15, and 16 for a while, but I am now working at 15. That's a fair handicap.

The general rule is, don't set a SCROOGE PILE so large that a kid or beginner can not ever win. Everybody should win a hand—and a game—on occasion. But if a person wins too often, he should get his SCROOGE PILE adjusted up....

Scoring: At the end of each HAND of play, after somebody has hollered "SCROOGE," the cards left in your SCROOGE PILE (that you could not get rid of) each count 2 points AGAINST you. Each of the cards played in the center (Aces, or on the Aces) counts one point FOR you.

At the end of each HAND, save your SCROOGE PILE, remember the number of cards in your SCROOGE PILE, and multiply by -2, and add that to the number of cards you played onto the center of the table. Hopefully, the result will be positive in most hands!! The scoring is listed here, so you can begin to see the PRIORITIES.

The SHUFFLE: Each player takes a standard deck of cards (52 cards, 4 suits, each with Ace and 2 up to KING). Shuffle them very well, at least 7 or 8 times, and pass them face-down to the person on your LEFT.* (*As soon as one person has reached a score of 75, the cards are passed instead to the RIGHT.) When you get your well-shuffled cards, CUT the deck by taking perhaps the top half of the deck, and moving it below the rest of the cards.

The LAYOUT: After you have CUT,

take the top 13** cards off the top of your new deck, one by one, and lay them down, one by one, face up, on the table, on the left side of the table in front of you. That is your SCROOGE PILE. (** 13—or as agreed upon.) Then lay the next 4 cards, side by side, in front of you. These are the BUILDING PILES. Hold all the other cards in your left hand and prepare to play. When every player has laid down their SCROOGE PILE and all 4 cards for the BUILDING PILES, play can begin. (If you want play to NOT start, do not put all your cards out.) Leave plenty of room below your 4 BUILDING PILES for building down, and for your DISCARD PILE. About 8 or 10 inches is good, from the 4 BUILDING cards to the edge of the table.

The PLAY: There are several things you can do. The PRIMARY objective is to get the cards off your SCROOGE PILE, and play them legally onto the 4 BUILDING PILES, or onto the Aces in the center (see "Play On Aces").

The NEXT priority is to play a lot of cards onto the center. To help you do this, you go through your HAND, 3 cards at a time. This may help BUILD your piles, or lead to combinations that can spring loose some of your SCROOGE PILE.

For example, let's say you have a 7 of Diamonds and a 5 of Hearts as 2 of your 4 BUILDING PILES, and a 3 of Diamonds on top of your SCROOGE PILE. What cards would you like to see? A black 4 would let you put the 4 on the 5, and the 3 on the 4. Similarly, a black 6 would let you put the 5 on the 6 on the 7—and this would have the further advantage of getting the number of your BUILDING PILES down to 3. See below:

Conventional Solitaire Play: On your 4 BUILDING PILES, the standard solitaire play is alternating colors and descending order. You can put any black 9 on any red 10, and then a red 8 on top of that, and then a black 7, and so on. Only those choices.

When you move a card to empty one BUILDING PILE, you can leave one of the 4 piles empty. Or you could fill it with one card from your SCROOGE PILE. If a second pile gets empty, you will usually fill it with

a card from the SCROOGE PILE. You could take a card from your DISCARD PILE, if that causes a great advantage. This might occur if you were nearly stuck.

Play On Aces: After play has started, any time you have an Ace, you can put it in the center of the table. Any time an Ace is out there, any player can put a 2 of the SAME suit on the Ace, and this continues, putting the 3 on the 2, etc., and the Jack on the 10, the Queen on that, and the King on top. After the King has been placed on the Queen, no other play in that suit can occur, and the stack may be ignored, or set aside. Often there are 10 or more piles building in the center of the table. This can be very hectic, and hard to keep track of.

Play From Your HAND: Take the first 3 cards off the top of your HAND, turn them over, and lay them down face-up in front of you, to make a DISCARD PILE. You can play the top card, if you can, onto the Aces, or onto the 4 BUILDING PILES. If you move that top card, then of course you could play the card under it—the new top card on the DISCARD PILE. If you cannot move or play the top card, then set down the NEXT 3 cards from your HAND onto the DISCARD PILE, and try to play the next one on top.

Go all the way through the HAND. At the end of this HAND, put down the last 1, 2, or 3 cards on the DISCARD PILE. Then you can pick up the entire DISCARD PILE, turn it over intact to be all facedown, and start all over with this as your new HAND.

Usually you go through your HAND fairly quickly, and only slow down when there is some other interesting move to be made. (Strategy: If you can play *one card* from your hand, then the next time you go through your HAND, you will see different cards. If you *don't*, you *won't*.) If you played 3 cards, you would tend to see mostly the same cards again, which may be considered disadvantageous.

SHORTCUT: At any time, you can always lay all your cards down and get at the last card. Thus, you can always grab the last card off the bottom of your HAND. Thus, it is useful to KNOW what the last card is—the

card on the BOTTOM of your hand so you can grab it and play it as soon as it useful. So as soon as you have laid out your SCROOGE PILE, you can check the card on the BOTTOM of your HAND and know what it is.

Be alert for amazing places to put it in play. It is NOT required to literally lay down your whole HAND to do this. You can just grab the last card. Then you can peek and see, what is the NEXT last card. (Reminder: At any time, you can peek at any card in your hand, to see what it is. Usually there is not much advantage to do this. But, if you lay down your 3 cards so you can see each of the three, you might find something amazing. Sometimes it may be advantageous to make a DUMB play on the top card of your DISCARD PILE, if there is a great advantage in getting at the card under it.)

Play Onto The BUILDING PILES: As soon as play has started, you can take a card off the top of your DISCARD PILE, and put it on a legal place ON TOP OF one of the 4 BUILDING piles. If you have 3 BUILDING PILES, you can ALSO take a card off your DISCARD PILE or off the SCROOGE pile, and put it UNDER one of the working piles.

For example, if you have a red 7, you can grab a black 8 off your SCROOGE PILE and slide it UNDER the red 7, because that is equivalent to laying down the black 8 on an empty slot in the BUILDING PILES, and moving the red 7 on top of it.

But you don't have to move that way; just shove it under the 7. This is neater if the red 7 has a lot of cards on top of it. BUT, you can only do this if there 3 or fewer piles. Likewise, if you are in 3 piles, you could grab that 8 of Clubs, and put it on a 7 of Clubs in the middle. It's a perfectly legal shortcut.

Similarly, you could take a card out of the middle of a run of cards in a BUILDING PILE, by moving part of the pile to an empty place, if there is a big advantage to get that middle card. For example, if you have 3 piles, and you want to grab the 8 of diamonds from between a black 7 and 9 in a BUILDING PILE, to spring loose the 9 of Diamonds on your SCROOGE PILE, and you have an 8 of hearts on your DISCARD, you can just swap it in. If you are stuck in 4

PEASE PORRIDGE

BOB PEASE

piles, you can't do that swap.

So, you can see that there are many advantages in staying in 3 piles. Sometimes you can be stuck in 4 piles for many minutes, and this can be a real DRAG. Sometimes, when you are in 3 piles, you decide to make some moves to get into 4 piles for a short time, in hopes of getting back into 3 shortly. If that doesn't work, you might be stuck in 4.

As you continue play, your priorities may change. Early on, building may be important to build up to a place where you can remove cards from your SCROOGE PILE. Later, there may be times when a specific combination can be built to help move things. If a long lost Ace shows up in the middle, you may build a lot of cards on THAT, to reduce clutter on your BUILDING PILES (and make a lot of points). Priorities usually vary 2 or 3 times per minute.

End Of The HAND: When one person empties his SCROOGE PILE down to zero, he can holler "SCROOGE!" That is supposed to end play. If another player has a card coming DOWN onto the table, that is OK, but if he is just picking a card UP to play it, and it is not yet coming DOWN, he should put it back.

House Rule: At our house, if a person has 3 BUILDING PILES, even after play has "stopped," he can move over a card from his SCROOGE PILE to fill in EMPTY slots to get the number of BUILDING PILES up to 4.

At this point, every player counts and saves and remembers the number of cards left in his SCROOGE PILE. Then all cards in your HAND and in your DISCARD PILE and in your BUILDING PILES are scooped together, and are not counted.

Note: The first player to empty his SCROOGE PILE is not REQUIRED to say that awful word; he can keep on playing if he sees any advantage.

One or two players usually merge all the Aces and the cards ON the Aces, ALL the cards in the center, and turn them over, and sort them by the backing, so each player will get his cards that he put into the center. Then each player counts those cards. His score for that hand is the number of Aces and cards on Aces, minus 2 points for each card left in the SCROOGE PILE. This total can be

plus or minus. After each hand is played, each player's score is added up. Keep score on paper. When one player has gotten his total up to 75 points, that requires the shuffled cards to be passed the opposite way.

End Of Game: When one player has gotten to 150 points, that ends the game, and the player ahead at the end of the round is the winner.

ONE HAND? Yes, you can only use one hand to put out 1 card at a time, on the Aces. (The exception is, you can use more than one hand, to put out 2 or more Aces.)

BACK UP? Normally you can not put a card BACK ON your SCROOGE PILE, or in your HAND, but if you picked it up to put it in a legal place in the center, and somebody beats you to it, then you have to put it back where it was.

STUCK? What if no player can make any legal move? This happens rarely with 4 players, but occasionally with 3 (often with 2). If that occurs, the players agree to stop play, and all the SCROOGE PILES are counted, and subtracted, etc.

STOP PLAY? If there is something important to do—answer the phone, or pick up something spilled, etc., all play can be stopped by request. No harm. Play is often stopped to permit large, messy stacks to be straightened up, or removed from the center when they are filled up to King....

WHY do I inflict this game on *you*? Because it is a good challenge for people of all ages. It keeps you active physically (well, at least your arms) and mentally. It is very challenging on your EYES, too.

Why do I propose to inflict this game on kids of all ages? Because kids need to learn difficult challenges. And in a game with fair handicaps, they have to be able to win occasionally. And they have to learn that life, like this game, is often unfair and nasty.

SCROOGE!

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@webteam.nsc.com—or:

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Bob's Mailbox

Dear Bob:

Silly Ideas That Work: Are you aware that the New York City subway system used incandescent bulbs in series strings of five so that they could be powered by 600 V from third-rail track power? To discourage bulb snatching, especially during the Great Depression, they also raised the bulb ratings to 135 V. This prolonged lamp life and made those 40-W bulbs so dim that it discouraged their pilferage.

They also had to introduce counter-clockwise Edison-base threads. That really put a stop to bulb-snatching! Most vandals gave up when the bulbs would not unscrew. Those who succeeded, quickly found that the bulbs were unusable at home. But I'll bet that didn't stop them from hawking them on the street to unsuspecting pedestrians!

On the down side, just like cheap Christmas tree light strings, when a string of five bulbs went dark, a transit worker would replace all five bulbs rather than attempting to locate the faulty one. When you consider that the probability of additional bulb failures in quick succession was high, replacing the whole lot was more efficient!

What Ya Don't Know Won't Hurt Ya: I prefer the charm of an oil or gas lamp with a mantle. You know those Coleman camping lanterns? Unfortunately, I made the mistake of buying a lovely little geiger counter made by a small company, Aware Electronics. The unit is shirtpocket sized and comes with software for data collection via a PC or with an optional counting/display module. It can power its GM tube (900 V dc) by stealing energy from a PC's serial port.

After running all over my neighborhood measuring residual radioactivity of clay coffee mugs, cut crystal glassware, the ledge in my garden, the radon in my water supply, I measured a spare package of mantles. Oops! The normal background count is 14.9 cpm, equal to 10 μ R/hour. But the mantles produced almost 12,000 cpm, equal to



8 mR/hour! Almost 1000 X normal background! With 100 mR/year, the average annual human exposure to naturally occurring radiation, carrying an envelope of new mantles in your trouser pocket for 13 hours exceeds it! I heard a tale about someone doing that for weeks, having forgotten that it was there, until a nasty red rash developed on his buttock.

Inhaling the dust while changing the mantles, something thousands of camping enthusiasts have no doubt done, can be quite dangerous. Particulate can imbed in lungs, exposing delicate tissues directly to penetrating beta radiation and even more potent (greater ionizing capability due to mass), though less penetrating, alpha radiation. And you thought the cigarette manufacturers were the only ones hiding carcinogenic complicity!

Older mantles, like this package that I had on the shelf for years, contain thorium to enhance light emission. Thoriated tungsten is used in electron tubes to enhance electron emission. Anyhow, the stuff is very radioactive. When you change old, burned-through mantles, you have a crumbling mess of radioactive debris and dust! Coleman no longer uses Thorium in their mantles. So much for efficient romantic lighting!

IRA A. WILNER
Wilner Associates
via e-mail

For 600-V operation, I'd put four 155-V bulbs in series. These bulbs would be of ZERO value to ordinary consumers who have 115 V—quite dim—yet fairly efficient and bright on 150 V. But, when thorium is outlawed, only outlaws will have thorium??—RAP

All for now. / Comments invited!
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What's All This Epaminandas Stuff, Anyhow?

Once upon a time there was a little boy named Epaminandas. (*This is an old esaeP's Fable.*) His mother told him to go out and play. So he went out and played around his neighborhood, and after a while, his neighbor Miss Suzie called to him, "Epaminandas, let me give you a nice piece of cake to take home to your mother." Epaminandas soon started home with a piece of cake in his hand.

But by the time he got home, the cake was in terrible condition, as the little boy had clenched it tightly in his fist. When he got home, his mother asked, "Epaminandas, what do you have there?" And the boy explained about the piece of cake. His mother said, "If anybody ever gives you a present like that, bring it home on top of your head."

The next day, Epaminandas went out to play. After he wandered around the neighborhood for a while, his Aunt Ann called out, "Epaminandas, come over here and I will give you something to take home to your mother." She gave Epaminandas a pound of freshly-churned butter. As soon as he got out of Aunt Ann's house, he put the butter on top of his head and put on his hat, and went directly home.

It was a hot day. When he got home, the last of the butter was just dribbling down his face, his back, and his ears... and his mother asked him, "Epaminandas, what do you have

there?" Epaminandas explained how his Aunt Ann had given him a gift, and he brought it home just like he had been told.

Epaminandas' mother was somewhat exasperated. She told him, "Epaminandas, you foolish boy, the next time somebody gives you a gift like that, you should take it down to the spring, and hold it under the water until it is cool, and then put it on some green leaves, and carry it home."

The next day, Epaminandas went out to play. He walked up by his Grandmother's house. She called out to him. "Epaminandas, I want to give you a kitten to take home." The little boy very faithfully took the kitten down to the spring, and held it under the water until it was cool. And like he was told, he then put it on some green leaves and brought it home.

When he got home, his mother soon figured out what had happened. She said, "Epaminandas, you foolish boy, if anybody ever gives you a gift like that again, put a string around its neck, and lead it home behind you."

The next day, Epaminandas went out to play. It was nearly noon when he went by his Aunt Dorothy's house, and she called out to Epaminandas to bring a gift home to his mother. She gave him a loaf of freshly-baked bread. He put a string around its neck, and led it all the way home. By the time he got home, there wasn't much left of it.

His mother said, "Epaminandas, you foolish boy, you surely do everything just wrong. Now, I am going out to do some shopping. You stay home. I just baked six pies. You mind how you step in the middle of those pies." So Epaminandas waited until his mother had left, and then he stepped *very carefully* right in the middle of each pie. (*End of Fable*)

This was a fable that my mother Beulah Pease used to tell me when I

was small. Surely an esaeP's Fable. I think I caught onto the message: that there were times when following explicit instructions could be wrong. Sometimes common sense is required. Even if the coach did tell you to run 3 plays and then punt, if you have been able to get down to the 5-yard line, first-and-goal, it might be reasonable to call a time-out and get permission to go in for the touchdown.

Now I just borrowed a copy of this old FABLE from a library. This story was published about 1912, and the only substantive difference between that story and what my mother told me was having a puppy instead of a kitten. And all the characters in that published story were African-American. I guess those days were closer to the days of slavery than 1997. I'll let you do the subtraction, and the politically-correct debates.... Having the characters in a story speak in Ebonics was "politically correct" or acceptable then. But my mother didn't tell it with Ebonics. Epaminandas was just another little boy. She sure did know a lot about little boys.

In fact, she used to tell me at times when I had gotten her really *provoked*, "When you grow up, I hope you have a little boy just like you." Such a terrible curse!!

My mother told me about the time when I was small and she was pouring me some milk. I said, "Enough." But she kept on pouring. So I took the glass away, and the milk spilled on the table. And she *whacked* me...and I don't doubt that I deserved it.

A number of years later, I was pouring some milk—out of a *glass* milk-bottle—for my 4-year-old son Benjamin. He said "Enough." He tried to pull his glass away. BUT I held the lip of the bottle on his glass, and I would not let him pull it away until I was ready to stop pouring. We never spilled a *drop*.

I sometimes see ads about the electronic circuits that can make a dog obey by giving them a shock when they get too close to a fence-line, or when they bark too much. My comment is, "Will it work on Product Engineers?" Because sometimes, product engineers are told exactly what to do—and then they go and do something else. Sometimes it is *exactly* wrong.... I know of some specific examples, but I refuse to recite them here.



BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
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Now, someone will surely say, "Bob, you wouldn't put an electronic shocker on a Product Engineer just because he made some mistakes, would you?" And he surely wouldn't like my answer—because I surely would. At least on a few of them that I have done business with. A couple that didn't have any better judgement than Epaminandas did....

One reader told me about the time he took his car in to get "smogged," recently. He instructed the technician that he should do the testing without linking the computer to the official computers in Sacramento, because it was not likely to pass—he suspected a leaky hose.

When he came back, he found that the technician had decided it probably would pass, so in order to save time, he left the computer linked up. Unfortunately, the car failed. The car was then listed PERMANENTLY as a "gross polluter." When the car's owner contacted the DMV in Sacramento, Calif., he was told that it was *impossible* to have the "gross polluter" designation removed. My advice to the owner was to have the technician figure out how to get it removed, because it was *his* mistake. If he couldn't undo his error, the owner should take the technician to small claims court. Sue him for several thousand dollars, which represented the decrease in value of the car from what it used to be worth. Or maybe he could get one of those dog-collars, and turn up the voltage, and take it out of his hide....

There are many times when a person has to break rules. He just has to be aware of the problems—or consequences—in case he has made an error when breaking the rule.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@webteam.nsc.com—or:

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

P.S. Note, there once was a man named Epaminondas who was a politician and general for Thebes in Ancient Greece about 405 to 362 BC. None of the stories I read about him indicated any problems with his failure to follow instructions.... / rap



What's All This Aptitude Stuff, Anyhow?

Once upon a time there was a very smart guy—let's call him Bob—who was getting lousy grades. (*This is another esaeP's Fable.*) He was in danger of flunking out of MIT, even though he had a very high IQ. His father sent him to the Human Engineering Lab (which I'll abbreviate as HEL) in Boston, to take a set of Aptitude Tests. When all the results were known, Bob took the report and went in to see the Dean of Students (who had been wanting to have a talk with him). Bob showed him the results—high scores in many aptitudes. The Dean went over to a file cabinet, unlocked it, and solemnly brought out—a goldfish bowl. It was stuffed full of dollar bills. He told the young man, "Bob, put your dollar in, too. Each of the dollars in here was put in by a person



BOB PEASE

OBTAINED A BSEE FROM MIT IN 1961 AND IS STAFF

SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

Did the Dean of Students ANYWHERE actually set up such a challenge? Maybe—maybe not.

Maybe the whole story is apocryphal. But there is an element of

truth about this. The first thing I must explain is that the young student "Bob" was not RAP. I never went to see the Dean of Students at MIT. I never took the HEL tests nor got my test results until 5 months after I graduated. I have never *seen* a goldfish bowl full of dollar bills. But I certainly can imagine one.

When I went to MIT, I was good at taking tests. Of all the guys I knew in my high school, I was about the best at taking tests. We had a math teacher, Pappy Mirtz, who explained at the beginning of the term, "This term we are not having any un-announced tests." Most of the class cheered. He grinned, wryly, "I am announcing them all, now." The class groaned. But the teachers who gave a little test every day did get a lot of respect, and they were generally very good teachers.

When I started taking tests at MIT, I figured out that the *cream* of 500 other schools—most of whom were the best test-takers in *their* schools—were all taking tests, and they were having problems. The first test I took in Physics 8.01 was very simple. I remember it perfectly: A small mass (m) comes along at velocity (v) and smacks into a larger mass ($2m$) at rest, and bounces back. Allowing for the conservation of momentum and of energy, what are the resulting speeds? I started out to do the test. I struggled, and realized I could not get the equations to work right. I figured out what the answer was, and crunched the equations together backwards until they gave the right answers—just in time to hand in the paper. (The answer is that the small mass bounces back with velocity $= -1/3 v$ and the larger mass moves forward at $2/3 v$. No momentum or energy is lost.)

Did the goldfish bowl of money ever get claimed by a graduate? Did the Dean of Students at MIT ever actually do that?

When we sat around before the next class, some guys were discussing what they thought the class average

would be. Some guys guessed 70 or 80 or 85. When the papers were returned, the class average was announced—50. Obviously, a lot of other kids had some troubles, too. More than I did.

Like I said before, I was always pretty good at taking tests. I figured out the right way to take them. We had 3-hour finals in our courses. For example, I went in well-prepared for the 5.02 final in the spring of 1958—General Chemistry. In the first hour, I did all the problems the best I could. I recognized that the test-makers were (as usual) putting in a lot of extraneous information and useless, distracting facts. In the second hour, I brought out a glass and a quart of Hampden Ale, and drank it. Meanwhile, I checked all my answers for dumb errors, as well as I could. At the end of the second hour, I packed up my stuff and handed in my exam and walked out. I figured I certainly couldn't improve my test results in the third hour by hanging around, but I might panic a poor few souls and improve my score compared to the class average. I did pass that exam. Not sure what I got; probably a B- or a C+, which was FAR above average on those tough chemistry exams. Hey, I knew how to drive a slide rule. Still do.

In the fall of my senior year, I was taking a course (8.721) in Advanced Physics. I won't say much about the poorly taught course (which was, many of us believed, designed to flunk out 1/2 of the senior class). But they gave us some homework problems. I didn't do them. I thought I knew how to do them. Then they showed us last year's final exam. It had the same problems. I didn't do the "practice exam." Then they showed us the previous year's exam. It had the same problems. I didn't do them. Previous year's homework, likewise.

When I went into the final—guess what problems were there. The same darned problems. I had to do them, so I did them. I passed the course. But they did manage to flunk half of the senior class. Meanwhile, I had decided that all this quantum-mechanical stuff was not very *physical*, so I bailed out and got into Electrical Engineering. Even as I was planning to survive that 8.721 class and its final, I was taking a couple of labs in Course VI (Electrical

Engineering) plus a couple of theoretical courses—and having FUN! So that is why I got my B.S. in EE, not in Physics. And I graduated in September of 1961, not in June, because I was taking so many courses in EE, that I couldn't start my thesis until June.

After I graduated, I went to work for Philbrick Researches. I was doing technical writing, and studying the design of op amps (with vacuum tubes, and germaniums, and silicon transistors, too). I learned from some pretty good engineers, too; Bob Malter, Tim Noble, George Philbrick, Bruce Seddon, and Al Pearlman. I learned some marketing angles from George and from Dan Sheingold. I saw some true MASTERS at work. I was having a LOT of fun!

Now, it is a fact that 5 months after I graduated, I went in to the Human Engineering Lab for some testing, because I was having so much fun. Why did I go in? Not sure. I guess a friend recommended it.

What did I learn? That I had good aptitudes at a LOT of things. Let me explain the Wiggly Block test: if you take a big block of wood, and use a jigsaw to cut it into several curvy pieces in the X dimension, and then *again* in the Y dimension, you get a group of blocks that are curvy, and they all fit together if you fit them wisely. A 4-by-5 matrix of 20 blocks. Assembling this puzzle from randomly turned and jumbled pieces is one of the standard old tests for engineering aptitudes at the HEL. They call this "Structural Visualization." Most engineers are very good at this test. Surgeons are. English majors ain't. The *absence* of Structural Visualization is called Abstract Visualization, and English majors usually have *this*. I did very well at assembling this Wiggly Block quickly. Heck, I could even do it with my eyes closed, with a blindfold.

What other tests did I do well at?

- Silograms, which is a name for a silly test that correlates well with learning languages.
- English language vocabulary. (Did then, still do, even though I still like a lot of short words.)
- Ideaphoria—ability to be innovative, creative, have lots of ideas.
- Accounting aptitude—the ability to check errors in numbers.

• All other Structural Visualization tests that correlate with the wiggly block and other engineering work.

- Objective personality.
- Analytical reasoning.
- Inductive reasoning.
- Number memory.
- Memory for Design.
- Tonal memory.
- Foresight.
- Counting backwards.
- Number reasoning.
- Spelling.
- Finger dexterity (right hand).

What tests did I score low on?

- Pitch discrimination.
- Timbre discrimination.
- Color-blindness. (I am slightly colorblind.)
- Finger and tweezer dexterity (left hand).
- Abstract visualization.

What does it mean if you have an aptitude and you aren't using it? You may, without noticing why, get frustrated. Let's say you have good musical aptitudes. If you have to drop out of a choir to work on "work," you may get frustrated, and yet not be able to put your finger on why. I had to drop out of a chorus, but I keep my licks by singing along with the radio. There are ways to exercise such aptitudes if you are aware that you have them.

What does it mean if you are doing OK in a job where your aptitudes are needed, but *your* aptitudes are low? You may be doing OK by working *hard* as a salesman, or a manager—but you may be getting frustrated. Maybe you should plan to shift your career into an area that's a better fit with your aptitudes.

What does it mean if you have too many aptitudes? It indicates that you are likely to be easily distracted, with too many irons in the fire. It makes it easy to be a jack-of-all-trades—and master of none. If you are aware of this, you can concentrate on the necessary tasks when it's really important, and get that task done. Like graduating from school. (Or completing a column before deadline.)

I have recommended to several engineers, and technicians, and friends, to take the HEL tests. Often, they learn about some aptitude, missing or

extra, that explains why they were not happy in their career.

So if you are curious why you are having fun at some job, or curious why you are doing OK even though you are *not* having fun, you might think about taking these tests.

The tests are of all sorts; in general, they are fun. They take three 3-1/2 hour sessions, typically (but not necessarily) on consecutive days. The fee in 1997 is \$480. Not cheap, but if it changes your life, it's a bargain.

Now, here's a curve: FORGET the name Human Engineering Laboratory. Call up the Johnson O'Connor Research Foundation, in any city listed below. THAT is the new name for the HEL. Ask for more information.

My wife has been tested. My kids have been tested. For example, we had Benjamin tested when he did so well at geometry that they put him into the advanced algebra section, where he struggled miserably. Benjamin's Structural Visualization is quite high, so he did well at geometry. (Probably he inherited it from his mother.) But his accounting aptitude is low, which means he makes lots of mistakes on numbers and codes, and he can't spot the mistakes. NOW it all makes sense!!

I almost forgot about the subject of aptitudes, because I gave a lecture on this at a local amateur science group several years ago, and then set it aside. Finally, I realized I had not written it up as a column. Here you are. Enjoy!

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@webteam.nsc.com—or:

Address:
Mail Stop D2597A
National Semiconductor
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Santa Clara, CA 95052-8090

Note: Johnson O'Connor Research Foundations are located in Atlanta, Boston, Chicago, Dallas/Fort Worth, Denver, Houston, Los Angeles, New York, San Francisco, Seattle, and Washington, D.C. Call (800) 452-1539 for more information. In Boston, ask for the Human Engineering Laboratory. The Johnson O'Connor Foundation has been a nonprofit education and research organization since 1922.

Bob's Mailbox

Hi, Bob:

A couple of things I have learned that make working with copper-clad boards much easier are the use of a hot-air soldering tool, and a good pair (sharp point) of tweezers for stripping the foil from the fiberglass substrate. Also, the pc-board prototype routing machines you see in a number of electronic publications are an excellent tool for doing almost any kind of work with copper-clad board—from cutting shaped pc-board pieces, to elaborate double-sided prototypes made for TSOP and SSOP devices.

The routing machine that I use (LPKF) will allow you to use a pointed-tip milling tool to quickly cut very-fine lines through the copper foil. It's much neater and faster than the X-acto knife I have used in the past. The hot-air soldering tool can be used to remove unwanted foil after all the routing and drilling is complete. A drill tool will drill holes, and a second milling tool will cut through the pc board.

Since the routing machine is basically a specialized plotter, controlling it is fairly simple. It came with fairly good software, but I find it easier to export files from the CAD tool I am familiar with in HPGL format. Making multiples of a board is a simple cut-and-paste operation, and making a duplicate board at a later date only requires loading a file. The L-shaped box you mentioned in your article would take about 15 minutes to layout, export, and rout. Two L-shaped boxes would take 16 minutes.

BOB LUTES

Design Engineer

M-tron Industries

Yankton, S.D.

Maybe 15 minutes for you. But 15 weeks for me to learn to drive that computer without crashing. Fortunately big SHEARS, tin-snips, and metal-nibblers still work well—RAP

Dear Bob:

New EE grads are a source of both enthusiasm and comic relief (providing



there's not a schedule to meet). Most are of the opinion that "there are 'digital' electronics and 'analog' electronics." Their various instructors never take time to warn them that "there's no such thing as 'digital'"—just funny-looking analog with more or less two common states."

Two things have become more common over the years. First, EE students are actually encouraged to treat digital circuits as ideal circuits, ignoring the analog component. Especially at the frequencies we're using today for these components, more circuits do not work as expected. Ah! too bad the world wasn't really a pile of capacitive and inductive elements.

The second problem seems to be in the selection of passive components. Is it my imagination, or are nearly all EE students leaving school with naivete that nominal value plus tolerance is all that matters? Why has it never dawned on them to ask why there are different materials available for resistors and capacitors? Using other than a ceramic capacitor seems to be thought of not as a possible design need, but a fashion statement <sigh>.

I recently ran across the *Passive Electronic Component Handbook* by Charles Harper, \$89.50, available from: <http://www.books.mcgraw-hill.com> Where are texts like this being used in EE courses?

CHRIS ANDERSON

via e-mail

There's also a book by Ian Sinclair on Passive Components, about \$30, ISBN 07506 02295, with good insights. But no school is going to use anything practical like THAT in any course. Are they?—RAP

All for now. / Comments invited!
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What's All This Camel Stuff, Anyhow?

Once upon a time, I worked at Teledyne Philbrick. Way back in 1975. We had had a good president, Bill Frusztajer, who came over from Crystalonics. But Teledyne decided to retire him and brought in a new president, Mr. Chechik.

Many people observed that Mr. Chechik was indecisive. Even with all of our help, he could not make up his mind for even a simple decision. In fact, there was a book that came out a few years later called *My Indecision is Final*. I immediately went out and bought the book—and was astonished to see that it was NOT about Mr. Chechik.

Finally, Teledyne decided to relieve Mr. Chechik of his problems, and they brought in a new president. His name was Bill Earley. We soon learned a lot

about Mr. Earley. He had a unique way of arguing. If he asked you to explain a problem, and you gave him an explanation, after a minute he would likely stop you and say, "I don't understand your explanation.

So you are a stupid explainer. You are wrong. I'll make a decision, and YOU LOSE because your explanation was lousy." In other words, he made his own stupidly an advantage, because he

BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

could claim at any time that his inability to understand your explanation was due to YOUR stupidity....

Twenty years later, if we had to find a way to make Dilbert's boss look good,

Mr. Earley could have done it. Bill Earley was not a real fan of engineers. He always thought that engineers were really dumb and had no sense. Product planning, he declared, was to be done by the marketing guys, and after they reached their conclusions, the engineers could just design what they were told to do. No, Mr. Earley did not make a lot of friends in Engineering.

Bill Earley thought that all engineers were only capable of designing products that nobody would want to buy. He told us all who was going to be in charge of new product planning.

Of course, at that time, most of the marketing guys at Philbrick had NO IDEA how to design a good product, but they were willing to try. AND of course at that time, there were engineers who had designed a lot of popular and successful new products, but our friend Bill didn't want to hear a peep out of them.

And the whole BUILDING had been paid for by the profits on the P2, which was designed by an engineer who knew that nobody asked for a P2, but he had confidence that if he made them, the business would come. If you want the detailed story about the P2, look up "What's All This Profit Stuff, Anyhow?" (ELECTRONIC DESIGN, Nov. 7, 1991, p. 115).

Well, the next few months after Mr. Earley arrived were not a lot of fun. He threw out a number of engineers who seemed to know what they were doing. Threw out a lot of good guys, including Dave Ludwig and George Lee. Other engineers just bailed out.

In the fall of 1975, I had some squabbles with manufacturing, because they told us that if we followed their guidelines and designed a good new product, the manufacturing guys could later tell us that they were NOT cost-effective, because we had designed them wrong. If we claimed

that we had followed their guidelines, that did not matter. A new low-cost circuit could be shown *retroactively* (by the manufacturing guys) to be MORE expensive than the old design, NOT cheaper to build. (This was mentioned in my old column "What's All This Cost-Accounting Stuff, Anyhow?" (ELECTRONIC DESIGN, Feb. 28, 1991, p. 87, or Aug. 19, 1996 reprints, p. 39)

So, I had a squabble with Bill Earley and the manufacturing guys. I did not win any arguments, because the manufacturing guys argued like Bill Earley did—if you don't like my argument, YOU are stupid. Coming down to the end of 1975, I came to the conclusion that there was no future for me at that company. Engineers were supposed to just shut up and do what they were told.

Further, I had been given the task of designing a new low-cost ADC. But they wanted a package and pin-out that was completely nonstandard vs. any other existing product. And the cost was completely arbitrary, so if you designed a product that everybody initially agreed was better, according to all the guidelines, it could later be declared to be NOT lower in manufacturing cost. So, I decided to leave the company. I would resign on the last day of 1975.

Now, let me digress to an old story—an EsaeP's Fable: Once upon a time there was an Arab who wanted to cross a wide desert. So he fed and watered his camel well, and got all necessary supplies, and started out. The very first afternoon, a sandstorm began to blow. The Arab got off his Camel and pitched his tent and climbed in, to wait out the storm.

After a while, the Camel said, "Master, pray let me put my nose under your tent, for the sand is blowing in my nose. If I suffocate, I cannot carry you across the desert." So the Arab let the camel put his nose under the tent.

Shortly thereafter, the Camel said, "Pray, Master, let me put my eyes under your tent, because the sand is blowing in my eyes, and if I go blind, I cannot carry you across the desert." So the Arab let the Camel put his eyes under the tent. THEN after a suitable delay, the Camel asked, "Pray, let me put my ears under your tent, as the sand is blowing my ears."—etc. This

was shortly followed by, "The sand is blowing on the cut on my shoulder, Pray let me put my Shoulder under your tent." And shortly the Camel pushed the Arab out of his own tent.

And THAT is the Fable of the Arab and the Camel. In other words, a Camel is anybody who can push you out of your own tent, by asking for just a little more....

For about 10 years at Philbrick, I had been giving out "Camel Awards" on the last day of the year. This was based on the concept that a Camel would ask for one specification, and then another, and another, and while not any one spec was prohibitively difficult, when the total picture was in focus, the combination of the specs made it *impossible*.

The perfect example was a guy who wanted one of our standard op amps, but with a little less voltage noise—and a little more gain—and a little less current noise, too ... until it became impossible. So every year for over 10 years, I gave out Camel Awards to various applications guys and sales guys.

I gave out plaques and certificates. I gave out little plastic camel figures that were painted gold. I zinged our marketing and sales guys, and heckled them for making various silly mistakes.

For the last day of 1975, I put together some real *zingers*. I made up a special award—not just a Bactrian, and not a dromedary, but a three-hump award. I fabricated it very carefully. Then I got an old 4701 Voltage-to-Frequency Converter, and doctored up the silk-screen to say "V-to-\$ Converter"—because it really did convert into *\$\$\$*. I put it under the first hump. Similarly, I put a 4702 Frequency-to-Voltage converter marked up to say "F-to-\$ Converter," under the third hump.

On the last day of 1975, as I tootled my little camel flute, I went down to give out the Camel Awards. We went down to the marketing area. There, with 70 people AND Charlie Lohmiller, the Company Photographer (whom I had invited down, just in case there might be some good photo opportunities). I then gave out the awards. I started out with some zingy ones, and then I got nastier. Finally I unveiled the three-hump award, as a special award for Mr. Earley.

Oooh—aah—giggle. I explained to

the group about the 4701 V-to-\$ Converter and the 4702 F-to-\$ Converter. Then, I explained that under the *middle* hump was—my resignation. I took it out and handed it to Bill Earley. I still have a photo somewhere of him smiling wanly as he started to read it. I explained that it was impossible to do my job any more with "management" doing what they did, and I walked out. Within four minutes, I started getting phone calls from old (ex-Philbrick) friends at Burr-Brown, Datel, and other competitors, congratulating me for doing such a good job on Bill Earley. Yeah, the news sure did get around fast.

Then, I went home for a New Year's Eve party with 30 friends. (I HAD told my wife I was quitting.) I told my friends that I had the 70 witnesses AND the Company Photographer, so there would be no mistake that I was REALLY resigning. No going back. And within a couple months, I moved out to California. But that's a whole 'nother story.

All for now. / Comments invited!
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rap@webteam.nsc.com—or:

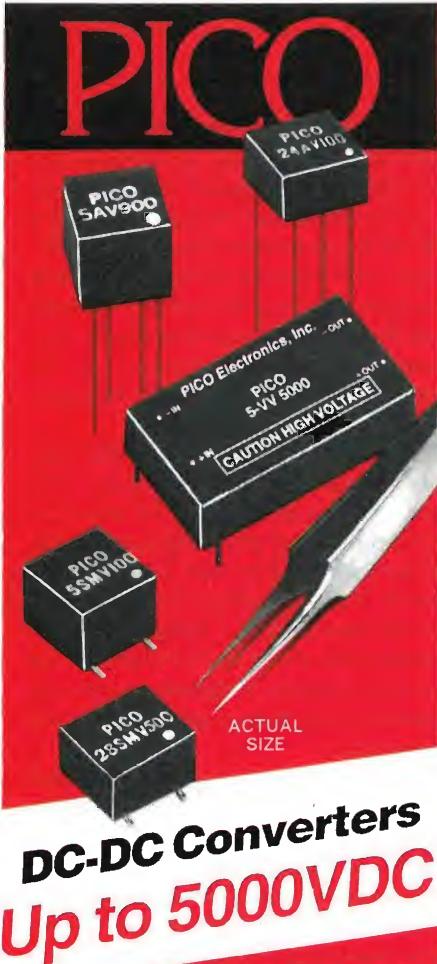
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P.S. On Friday morning, January 2, 1976, I drove down to work. When I got there, there was 5 inches of new snow all over the parking lot—and no cars. I laughed and laughed. The only guy to show up on that Friday was the guy who had just resigned. Nobody had told me that was a holiday. /rap

P.P.S. If you want to hear about how our Annapurna trek comes out, send me an e-mail or snail-mail request and I'll send you a report on ~Dec. 15. (It may take another month to get pictures on my web site.) We did get the trip filled up to 15 people. /rap

Circle 550 if you want to find out how exactly the three-hump award was constructed.

Circle 551 if you have you ever quit more emphatically than that.



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READER SERVICE NUMBER 108

Bob's Mailbox

Dear Bob:

Re: Paul Leonard and his comments on trekking in the Sept. 15 "Bob's Mailbox." INSPIRATION is something that's desperately needed in today's electronics industry. And getting away from the computer, the desk, and drawing board and thinking about the great outdoors allows the brain to create, as opposed to reworking old ideas. And let's be honest—how many new ideas happen today? Most are squashed-up combinations of existing ideas. Where are today's Colpitts, Hartleys, Edisons, Morses, Bells, and Marconis?

Contemplate the ratio of the circumference of your head first to the circumference of the Earth, then to that of the solar system, and you may be able to cope with the ratio of head to galaxy, but at that point the brain says, "Hey, man, this is beyond conventional thought!" At this point, the brain may go into overdrive and creativity may occur. Or it gives up and looks for something it can comprehend. In the great outdoors, there really is nothing that can be consciously comprehended. How does a pinhead-size seed grow into a tree? I could at this point believe in God, but I prefer to accept that mankind's lack of comprehension requires a God to explain the unexplainable. After all, who believes in the *Rain God* today? OK, OK, so the great outdoor rain can be comprehended, but where were the two H_2 and the O_2 before the big bang, and where did they come from in the first place?

One of my best inspirations came in a forest north of the Arctic Circle as I enjoyed the midnight twilight. It was a blast of creativity that I guess was layered down under ages of routine miniaturization of existing circuits and repackaging of old ideas. And no, it is not for publication—if it works it will make enough money for me to go to Nepal and return to Finland (I hope).

At the end of August, I sat on a cliff-top in West Wales looking over the ocean at a distant flash of a lighthouse



on some isolated rock. And I wondered: was it transistorized timer operating a power semiconductor or lenses in a rotating metal frame floating on mercury round a constantly lit lamp? I'll never know for sure, but it made me think about old and new methods. Came up with several reasons why the floating on mercury was the better method.

(*Yeah, but not far north of the arctic circle!!! Nor on Lake Superior, where it gets below -40°C—rigging a heater for the mercury might be too much work!—RAP*)

And to Mike McGinn, who also commented on trekking in the same issue. Mike, about your list of "I can'ts." I hope that you write it in pencil and keep an eraser next to it. A girl I know has a terrible time with cardiac illness. Her list of "I can'ts" is written in pencil, except for the top item which is "I can't give up until this list is empty" and written in ink.

On occasion, she manages to rub out a "I can't" and rewrite it in ink on the "I did" list. Against all odds she has made it to the age when portable, intelligent heart defibrillators are available, giving her more freedom of movement. One day, hopefully, a transplant may cure her. Until then, her eraser will be busy, but the list will grow. She told me that each "I can't" was read as "I can't yet." And if any reader doesn't carry an organ-donor card, why not?

BERNARD GREEN
via e-mail

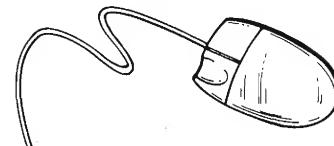
(*Note to Mike: Fortunately, you ARE able to go hiking. You just can't go far from civilization where WHEELS and cheap electric power make your dialysis feasible.—RAP*)

All for now. / Comments invited!
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What's All This Breadboarding Stuff, Anyhow?

After I sent out a brief note, confirming that we rarely see anything written down about how to do breadboarding, the letters and e-mail started coming.

This e-mail's from Graeme Nisbet in Germany:

To: RAP
Subject: Breadboarding

Regarding the letter from Barry Lunt in "Bob's Mailbox" (Electronic Design, Aug. 18th, 1997), I have the following advice:

Get in touch with Wainwright Instruments in Germany (or your local distributor), and order some of the "Wainwright Prototyping System" kit. It consists of various sizes of double-sided board, along with a huge assortment of self-adhesive pieces of

glass-fibre board with various package land patterns preetched onto the surface. They supply land patterns for just about any package you can think of—DIL, surface mount, discrete devices, you name it!

You also can purchase self-adhesive transmission lines ($50\ \Omega$, $75\ \Omega$, $150\ \Omega$, etc.), and low-profile tracks for power-supply distribution. These can be cut to the required length before being stuck

down onto the ground plane. Creating a circuit requires you to stick down the appropriate land patterns, solder down the components, then wire up the circuit. You can create circuit

boards very quickly, and it's good up to about 2 GHz.

I first used this product over ten years ago and I have NEVER used anything else since. I now use it for analog, digital, and RF boards. Keep up the good work in your column.

I promptly replied to Graeme, that I, myself, like to use strips of copper-clad for breadboarding. I had heard of the Wainwright stuff, but I could not guess where to find the distributor.

I also like to use wire-wrap sockets, tack soldered onto ground planes of copper-clad. I never use wire-wrap, but I just like the long, heavy, metal pins, as I can bend them over and get good access.

Shortly thereafter, I got this reply:

Hi Bob: Sorry for the delay, but I lost my Wainwright catalogue and had to contact the U.K. distributor for a new one. Anyway it has now arrived and the manufacturer's details are as follows:

Wainwright Mini-Mount-System
Aufbau von Versuchsschaltungen
Hartstr. 28c,
D-82346 Andechs
Germany
Tel. 081 52/3162
Fax. 081 52/40525

Graeme, We will try to find out if there is any local distributor, in the U.S.

This next e-mail comes from Ed Maddox, in Massachusetts:

To: Robert A. Pease
Subject: Breadboarding

First, a departure from the announced subject to say HELLO by way of the modern technology. My company won't spring for the expense of full net connections, but the e-mail is in use all the time.

I have never tried to record some breadboarding rules before, but here

are a few of my construction guides extracted from memory.

1. Abandon the plug-in-the-lead variety of white protoboards when:

- The frequency of interest exceeds 500 kHz or so. (And don't forget harmonics!)

- The design calls for capacitor values lower than 100 pF.

- An unexpected presence of 10 or 20 pF between points would be disturbing.

- Unexpected resistances of $0.5\ \Omega$ or so in the component paths would hurt.

- The circuit will have currents of over 100 mA.

- The operating voltage will exceed 150 V.

- You have anything else that one might have learned is a no-no.

2. Try as the second level, the patterned-etched circuit boards which give you good locations for dip sockets and leaded components. They require a minimum usage of insulated wire connections, if you plan a little. It won't hurt to branch out into the air for later thoughts and changes, if you shorten the component leads for those cases where series inductance may get in your way, and/or stray capacity needs to be kept low.^{1,2}

3. If you are going to go on up in the spectrum to 30 or 100 MHz and higher:

- Start building over a ground plane of copper-clad glass epoxy, like circuit boards. A width of 2 to 3 in. by 8- to 10-in. long is a good start. Grounded leads are just tacked to the copper clad with solder.

- Up in this part of the spectrum with some gain (amplification), plan your signal flow with the input at one side, and a steady progress toward the other side of the ground plane. (Actually, this flow is good at any speed.)

- A total gain of 40 dB or more should be separated into 20-dB or smaller pieces by erecting vertical shield walls across the ground plane along the signal path. Notches in the bottom edge of the shield wall can pass the signal and supply lines, and the walls make good places to add supply bypass capacitors.

- Passing 100 MHz, it would be prudent to add one or two side-walls to the



BOB PEASE

OBAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

down onto the ground plane. Creating a circuit requires you to stick down the appropriate land patterns, solder down the components, then wire up the circuit. You can create circuit

ground plane and shield walls. These are still all made of copper-clad circuit-board stock. The walls should be as high as the ground plane is wide. When you KNOW that your circuit will work, and you need to make an efficient product assembly, you can then tackle the challenge of reducing the need for shields and walls.

Notes:

1. When you allow yourself to branch into the air, you will be joining one of the World-Class Breadboarders—Robert A. Pease.

2. It is possible to construct a decent audio-frequency circuit on nothing more than bus wires running from side to side, with buses for the plus supply, logic supply, ground, and minus supply. Components are wired point-to-point, vertically from bus-to-other, or bus-to-bus. The components end up supporting the buses.

P.S. I had one that reached a 7-ft. length once. It contained a major portion of an audio-spectrum remote-control system with control to, and metering from, broadcast-station transmitters and similar systems.

Well, I promptly sent a hello back to Ed, agreeing with him on many items. But I added four more caveats to his part 1:

- I would avoid the solderless breadboards for frequencies that are above 50 kHz.

- I would beware when inductance would hurt, for example, if there is a lot of di/dt , such as in a switching regulator. Or, when a bypass capacitor must be right near an IC, and the long paths won't let you do that.

- I'd avoid them when leakage between nodes would be harmful, as the nylon is not necessarily a high impedance in warm, damp weather.

- I also pointed out to Ed that the care you put into your breadboard depends on what you plan to do with it when you get it running.

Then I got some more e-mails on this subject. (BOY, I am getting a LOT of e-mail these days!) This one is from Greg Lee:

To: RAP

Subject: Inquiry About Prototyping.

The "ARRL Handbook" and the "Art of Electronics" have excellent material on prototyping. Also Linear Technology's (blasphemy!) Application Note 47 is excellent. I'm glad to hear there are academic people concerned about this stuff.

I checked into the ARRL Handbook, and it does have several very good practical pages on this topic. Likewise Hurwitz and Hill's book—The Art of Electronics—has a very good chapter. More good advice. If you don't want to spend the money for this kind of info, get your Librarian to order them. Every good library should have those two books.

Then I got one more e-mail on this topic from: Mark Balch:

To: Bob Pease

Subject: Breadboarding Skills

What a coincidence!

- Last week I hear that you're trekking with my father and Peter Owens.

- You write that "students are not learning about breadboarding skills."

(Heck, most engineering students are not even able to get any lab courses at all, not to mention the NUANCES of breadboarding. /rap)

- Practical EE education at the college level is a topic that I feel very strongly about. So, how could I not reply with my own opinions?

Anyway, it's too bad that some academic institutions frown upon instructing students in "vocational topics" such as soldering and prototyping. There are many well-meaning professors and deans who seem to believe that presenting anything less than multidimensional Fourier transforms and deriving Biot-Savart's law is beneath the mission of higher education. I believe that the major purpose of an engineering education is to prepare a person to function as a capable engineer. Part of being an engineer is understanding how your circuits need to be constructed. It's great if you design a high-frequency amplifier, but you also need to build the thing to make it work.

I think that certain curriculums are missing the connection between EE theory and EE implementation.

That critical bridge separates the world of the clean classroom from the development lab. There are too many EEs who graduate from college completely unaware of non-idealities, and who have little breadboarding experience. It is true that much of this knowledge can be acquired in the first years of one's career. However, this great disconnect between theory and implementation scares many graduates away from becoming engineers. Instead, many choose to pursue graduate degrees in lieu of work. The disconnect often intensifies, and instead of joining the engineering community, these people go back into academia as professors. This is not a good cycle. Perhaps colleges should hire as professors engineers with years of solid experience?

(Naw-how could they ever be so practical?? /rap)

As for solutions to this problem... The best solution is co-op where a student takes a bit longer to earn a degree, but spends a significant amount of time working for a real company producing a real product.

(Check. /rap)

The second best solution is an emphasis on interesting, relaxed lab work. Don't give eight canned lab projects to a student each semester. Sit down with each individual student and come up with a development path.

"So you find walkie-talkies interesting? How would you like to try and build your own? You start by building an oscillator..." But this approach requires a great investment of time and motivation on the part of the instructor. Is it a price that our higher education community wants to pay?

WELL—I sent Mark a nice long note indicating all the places I agreed with him. I asked him if he thought the world didn't need a "Pease-Balch College of Practical Electronics and Hard Knocks (and Breadboarding)." That may take a little time, though.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@webteam.nsc.com—or:

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Santa Clara, CA 95052-8090

Bob's Mailbox

Hi Bob:

Hope all is well, and if you're on your trek, that you haven't fallen off a mountain trail. I've truly enjoyed reading your columns over the years. You seem to have that magic blend that most writers strive for—and the lucky ones reach. You are also a never-ending source of knowledge.

Having said that, I need to call upon your vast resources. Do you know of any listing of company logos that can help me identify who made a particular IC?

Usually, I'm pretty good at figuring out which company made what IC, and can scurry off to my data books, or the web to retrieve the relevant data sheet. But I've found one that has me stumped. The logo is a stylized letter, looking something like a cursive lowercase "d" in a circle with a flatted bottom—think Integrated Device Technologies, and you'd be close. I don't think they made it, though, as the part number (78K324L-28IH) doesn't match anything I could find.

So, great Guru of Arcania, can you point me to a logo listing that might help me in my quest? I shall remain ever-grateful, and promise not to bug you with trivial matters like this ever again! I had such a listing years ago, but lent it to someone who never gave it back. Boy, if I EVER see that guy again... Anyway, thanks, and I hope the pix you snap for the gentleman tethered to the kidney machine come out great.

JIM JERZYCKE

via e-mail

Just before we went to press, Mr. Jerzycke admitted that his technician observed, "That looks like the mark of Silicon Systems,"—and he was right. (Old D.A.T.A. book had good lists of semiconductor trademarks.)—RAP

Dear Bob:

In case you ever wondered why ignorance rises to the executive level,



here is a simple explanation that is also mathematical proof:

Postulate 1: Knowledge is Power.

Postulate 2: Time is Money.

Physics teaches us the following formula for Power:

$$\text{Power} = \text{Work}/\text{Time}$$

If Knowledge = Power, And Time = Money (based on above postulates), then by substitution we get:

$$\text{Knowledge} = \text{Work}/\text{Money}$$

Solving for Money, we get:

$$\text{Money} = \text{Work}/\text{Knowledge}$$

Thus Money approaches infinity as Knowledge approaches zero, regardless of the work done. What this means is: The less you know, the more you make. I KNEW this could eventually be proven!

DENIS M. POIRIER

via e-mail

Hello, Denis. I love it! This is almost as good an argument as the question, "Which would you rather have, a crust of bread, or a hot roast-beef sandwich?"

Of course the correct answer is: "A crust of bread."

Why? Because everybody knows that a crust of bread is better than nothing, and nothing is better than a hot roast-beef sandwich.—RAP

Hi, Bob:

I've been thinking how (not so long ago) in the warm and fuzzy days of vacuum-tube equipment, we were accustomed to waiting for equipment to warm up before it could be used. Some equipment, like RF generators, took so long to stabilize, we left them on all the time. Then came analog solid-state equipment. It was ready to work instantly when you turned it on and off as needed.

But now that most everything is digital, you often have to wait for it to

"boot up" instead of warm up. Recently, I had the privilege of learning how to use a fancy new audio analyzer. Just like a PC, you had to wait for it to go through a lengthy boot-up cycle.

(Not to mention the wonderful "self-calibration" cycle, one or more minutes?—RAP)

This wouldn't be so bad if you only had to do it once, but unfortunately, like a PC, it also had a habit of crashing without warning.

When it worked, it did a lot of nifty things. But it would occasionally just lock up—forcing you to power down and start all over again. There were other times when it would seem to be working, but not giving meaningful readings. The only solution, again, was to power down and reboot. Isn't progress wonderful?

KEN LUNDGREN

via e-mail

Yeah, computers are wonderful, except when they are trouble. Have you griped to the manufacturer? They may not respond, but at least you explained why you won't buy that brand of equipment again.—RAP

Dear Robert:

I read your article on Scrooge, and I remember playing a similar game with some friends. Their twist on the rules was that most "players" were teams of two, sitting adjacent to each other. One turned the cards while the other one played on the center. When I said "most," it was because one guy was so quick, and had such good vision and coordination, that his handicap was that he had to play alone against the teams of pairs. His day job? He was an air traffic controller.

BRUCE WALKER

via e-mail

Bruce your variation sounds very challenging, and we gotta try it! Yeah, our friend Willy could very well have been an ATC wizard, but he mostly wrote software.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@web team.nsc.com—or:

Address:

Mail Stop D2597A

National Semiconductor

P.O. Box 58090

Santa Clara, CA 95052-8090

What's All This Motorcycling Stuff, Anyhow?

Once upon a time, in the era 1950 to 1960, I rode my bicycles a lot. I probably rode 20,000 miles or more. Heavy old bicycles, light touring bikes, racing bikes. Track machines with a single fixed gear and no free wheel. Tandems. I knew how to handle a bicycle pretty well. But I knew nothing about motorcycles. I never even rode a motorcycle—until three days ago.

I noticed some signs when I was in Kathmandu, in April of 1996: "Motorbikes for Rent." But I did not ask about the details. This year, I decided to inquire. In Pokhara, a guy quoted me a price of 300 rupees per day. But I was just curious; I was not going to rent a motorbike there. After our successful trek, when I got back to Thamel (the tourist area of Kathmandu), I went up

the main street from our hotel (the Potala Guest House) toward the top of the hill. There was a big sign, "Honda Motorbikes, 250, 125, 50 cc for Hire." I inquired. The guy had no 50 or 125 ccs, but only 250 ccs, and he said they were 1200 rupees per day. That's 20 bucks! Not cheap, and I told him so, and walked out.

Then at the top of the hill, I inquired, and they had a rate of 500 rupees for a Yamaha. I figured I could live with that price—\$8 per day. The fact that I had never ridden a motorcycle before was not a concern. I could do some on-the-job training. No problem.



BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

After all, a clutch is a clutch, right? And a cycle is a cycle. I knew I could handle THOSE details. After that, I wasn't going to sweat the small stuff.

They held my passport as security—they didn't deal with credit cards. They didn't pay much attention to my driver's license, though they did look at it. Then, they helped me get the engine started. I figured out which lever was for the clutch, and which one for the brake.

NOTE: When I was a kid, the right-hand brake on a bicycle was always the front brake, and I liked that, as my right hand was stronger, and I could control the braking best with my right hand on the front brakes. More recently I have been finding that, alas, most new bicycles have the front brakes controlled by the left-hand brake lever. Why the change? I assumed that was because motorcycles have the front brakes controlled by the left-hand lever. WRONG. Motorcycles use the right hand for the front brakes. The left hand is used for the clutch. Minor surprise. (Why did bicycles change?)

Also, I immediately found that even though the signs said "Motorbike," this was a real motorcycle. The speedometer went all the way up to 120 km per hour (though I did not). Even though its engine was just 135 cc, it was a full-sized machine, and it probably weighed 250 lb. Fortunately, I'm a big, strong guy, and did not have any trouble keeping my balance.

I started down the streets of North Thamel, and the manager came along by bicycle to show me where I should buy some gas, because the fuel tank was empty. I filled it up with about \$6.40 for 10 liters. Then I started north for the Ring Road.

Anybody who has never been to Kathmandu might think that its "Ring Road" is a circumferential road like Route 128 around Boston, or the Ring

Road (motorway) around London, a divided highway, limited access, with two or three lanes in each direction. Not quite so. This road is about three lanes wide, TOTAL, and is usually filled with at least four lanes of traffic. Often, a truck will go to pass a bicycle, and a motorcycle will go to pass the truck, and a sedan will honk to pass as soon as he can get his passing lane. And what if the oncoming traffic consists of a bus passing a bicycle passing a water-buffalo? All in three lanes? (Not to mention an occasional wandering cow or a herd of goats.) Let's just say that the traffic on Kathmandu's Ring Road has no relationship to any traffic pattern in the USA or Europe.

However, when the Ring Road was NOT full, it was one of the widest, straightest, and smoothest roads in the whole valley. Later I got the little Yamaha into fourth gear, and wound it out to 50. Wow, that seemed really fast! Then I realized it was 50 km per hour, barely 33 mph. But that was still plenty fast for me. I never did find any roads long enough, straight enough, or empty enough for me to push it up above 45 mph.

I chose some less-travelled roads to get out to the Ring Road, and as I went, I learned how to ride that cycle. I discovered how to shift, and how to use the front and back brakes. And, how to use the horn. I never did find out how to get it surely into neutral. The procedure that seemed to work sometimes, did not work ALL the time. But, no harm.

I never did figure out how to operate my camcorder while riding. It's too bad—and it's also probably a good thing, not to try to do two complicated things at once.

My primary objective that day was to go to Nagarkot, which is a small town on a high ridge about 20 km northeast of Bhaktapur, which is 10 km southeast of Kathmandu. This place is supposed to have a good view of the mountains. I wandered southeast around the city until I hit the electric, trackless trolley lines going to Bhaktapur. Then, I went down along that road to the east. After a while I jogged off to the north, and then cut back east, to take the road toward Nagarkot. It was actually well marked by a sign in English, "Nagarkot, 20 km." The road started out fairly straight, through

pleasant farmland, and then started curving up through the foothills. I had to pay a little bribe when some local guys put a rope across the road. They were raising funds to finance a local recreation center. I also had to pay a toll of 2 rupees (3 cents) to go up the road to Nagarkot. The road was not narrow, not scary, not bumpy, and not steep. It was sort of like Mt. Hamilton Road in San Jose—upgrades and curvy, with not a lot of traffic.

After a few villages, I began to get good views. But rather than stop early and take pictures, I decided to go up to the top and take pictures, then take more on the way down. There were several tourist hotels and restaurants that were advertising themselves as I came into the town of Nagarkot. I just kept going up through pastures and then forests.

Soon I was following only one other motorcycle. The road turned from good tar to dirt. He kept going. I followed. The road got a little steeper, and a little rougher, and I had to use good judgement to pick a route up the rough road. Sometimes I followed the other bike, and sometimes he let me go ahead.

I learned, as I went, how to make a motorcycle go up a fairly steep hill. I must say, even at 6 or 8 mph, that little Yamaha had pretty good guts and torque. In general, it would not quit. All I had to do was keep applying a lot of throttle and keep it steering around the worst bumps and ruts.

After about a mile, I was near the top, as it leveled off, and I could see the summit tower. I came around a corner—and there were a dozen big buses, a dozen cars, and a few dozen motorcycles, all parked. It was NOT the end of the road, but the road did start down to the south, and I did not want to go farther. I parked, and took a walk. There were many people, sightseeing and picnicking on the Saturday afternoon.

The summit area was quite brushy and wooded. I followed several small trails. At first I thought I might have sneaked through small trails to an area where a fee was required, but later I found that was not so. There was an area with a small (40-ft.) fire tower. I did not go up there, as maybe a fee or ticket was required. I took some pictures from the heliport area.

The complete facade of the Langtang peaks and a great continuous wall of peaks to the north, northeast, and east was quite glorious, (Raamro). And the great peaks in the northwest, Ganesh Himal and Manaslu also were beautiful. Even though the day had started fairly hazy down in Kathmandu, it was quite clear up there. I gazed off to the east—a GREAT wall of mountains. Later I learned that Mt. Everest is visible amidst the far eastern peaks. But it is not very high on the horizon, as it is so far away that peaks that are closer appear higher.

I took several photos with my 35-mm camera, some views with my camcorder, and finished off the last few shots on my panoramic camera. THEN, I noticed the views of the Annapurnas and of Dhaulagiri in the far west. The Annapurnas stood as spires; Dhaulagiri was like a big wall, probably 80 miles away. As I had been studying its visage from close up for a week, I recognized it instantly. (The view of Dhaulagiri was good from the top of the hill at Nagarkot, but not from down in the town.)

But now I have no question that one can see HUNDREDS of kilometers in various directions from Nagarkot. Even if you do not rent a motorcycle, you can easily hire a taxi to take you out to Nagarkot for a half day. A rate of about \$50 would not be bad if split between two or three people. But for best viewing, you should plan to get there for daybreak, and the early morning viewing when the clouds are less likely to hurt your views.

Could you actually arrange to hire a taxi at 4 a.m. and get out to Nagarkot by daybreak? Maybe, maybe not. You could always ask. You might have to go out in the evening and stay overnight. There are inexpensive buses, if you are not in a hurry.

My primary reason to rent a motorcycle was NOT just to duck the high price of car rental in Nepal. In Nepal, as in other Asian countries, renting a car includes the hire of a driver. Hertz or Avis will cheerfully rent you a car (with driver), at rates of perhaps \$100 to \$200 per day. Last year, I decided to hire a taxi from a good guy named Gobal for an all-day 200 km trip to the Tibet border at Kodari. I specifically hired this guy with his taxi because I had ridden with him, and he was care-

ful, thoughtful, and considerate, which I cannot say of all drivers in Nepal. It was a very good trip, and \$80 covered the whole day. If you want to hire a good driver, go to the Potala Guest House and ask for Gobal.

But, I was not just trying to avoid cars, drivers, or costs. I wanted to rent a motorbike for the adventure, to see what would happen. Nepal is an amazing place. Especially if you are open to opportunities as they arise.

I rode back down to Thamel. The rental place was surprised and delighted to see their machine in one piece, as they obviously expected this KLUTZ to wreck their motorcycle. I told them I wanted to rent it the next two days. On Sunday I rented it again, but I only rode a few miles, downtown to buy some glasses, and then up to Batbhateni to talk with some engineers at Lotus Energy.

On Monday, I got an early start at 6:45 a.m., to avoid the heaviest traffic. I drove far south along the Ring Road to get to the small town of Beresshi, and continued up to St. Xavier's School. Peter Owens (of the trek) had told me that one could go up a road to the hill of Pulchowki, which means, Place (Chowk) of Flowers (Pul). He did not caution me how rough the road was, only that it went up to 9,000 feet, with a great outlook over the valley.

So, up I went. The road was alternately paved and gravel, and then with loose stones. It was not really very STEEP, but it was not an easy road. Any good car with good ground clearance (even my VW Beetle) could have easily made it up, but the motorcycle had problems as it kept bouncing over the loose rocks. It was not very stable at all.

I discovered out that just trying to STEER was not very effective, as the wheels were (effectively) not on the ground. But using my feet to dab at the ground worked pretty well. All the while, I toiled up the hill, at nearly full throttle, at 5 mph. I had to stop and back down a couple times, and then restart to go up. I saw no other vehicles or people on the way up, but at the top I met a family with six children and two kids. When they tied the small goats to the Hindu shrine at the top, I pieced together why THEY were there.

I walked around the top. There was an antenna farm for radio and TV, as



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ELECTRONIC DESIGN
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well as Hindu and Buddhist shrines. Again, the view of the mountains was very impressive, though not quite as clear as the previous days. But the valley was hazy, and looking over it was quite interesting. I could see across to Nagarkot where I had been two days earlier.

The descent was not easy, but I used my rear brakes A LOT, my front brakes a little, and got down OK. On the way down I saw three other motorcycles going up, and each seemed to have some struggles. I could see places with gravel torn up as they tried to get going on the steep upgrade. Note: In 13 km (40,000 ft.) the road ascends about 3000 ft—plenty steep enough. There also is a hiking trail that is much shorter and more direct, but it would have taken me ALL DAY, to hike it.

As I descended the paved road through Beresshi, I heard several noisy mills where polyester fabric was being woven. There are more than two dozen looms in little old brick buildings. I never saw any such looms in any other area of Nepal.

By this point I was very weary of sitting, and went back to my hotel. I went to Lakshminarayanan's Restaurant, and ordered a beer and some Chinese Chop Suey. (The menu said chop suey, but I knew what they meant.) Then I took a nap, three hours.

Later, I went down to New Road to pick up my new glasses, and up to Lotus Energy to pick up my modified Khukri knife and sign off some paperwork. Then I returned the motorcycle to the rental place.

When they inquired, I merely told them that I had gone up to Trisuli Bazaar. They were impressed. I mean, I didn't want them to think that I had trashed their bike. I also didn't want to explain why I took it up Pulchowki.

But when I told Peter, Jai, and Buddi that I had ridden the motorbike up Pulchowki, they were really impressed. Jai could not quite believe that I had never ridden a motorcycle before, yet had ridden up Pulchowki. But that's the truth. I have the pictures to prove it.

I wouldn't recommend this to everyone—that they learn to ride a motorcycle in Nepal. As I have ridden many thousands of miles bicycling, under every difficult condition, I had had

some preparation. Because I know how to slip my clutch by foot, I could figure out how to do it by hand, too. As I knew how to navigate around Kathmandu by sight, and by memory, I did not get lost too often. That's a good thing, as there are almost no street signs in Kathmandu. In fact, most of the streets do not even have any names. So I just navigated by internal guidance. (But I also had good maps.) And, as I was a student of the traffic in Nepal, I figured out that riding smoothly and steadily, even though I could not be aware of all the traffic bearing down on me, meant I had a chance to not get run over. And I also knew enough, not to take chances.

On Sunday evening we were going over to supper at a restaurant in the Thamel area, Thamel House. Of course, this was a building without a number, on a street without a name. Jeevan said, "I could direct you to get to the right place if I ride behind you." I replied, "Maybe so, but I would NOT recommend this, as I want you to get there ALIVE." So I drove over on my own and had no trouble finding the place. The weight of another rider swaying around behind me was a new experiment I did not want to take! Not at night. Not with a guy whose life I valued.

So much for experiments. I learned a lot. I did not kill myself, nor cows, chickens, pedestrians, or bicyclists. Though I might have scared a few of each.

And now that I am back in California, am I going to take up motorcycling or buy a cycle? Absolutely not. Much too dangerous!

All for now. / Comments invited!
 RAP / Robert A. Pease / Engineer
 rap@webteam.nsc.com—or:

Mail Stop D2597A
 National Semiconductor
 P.O. Box 58090
 Santa Clara, CA 95052-8090

P.S. A friend of mine suggested that people who want to take up motorcycling without killing themselves should read *Motorcycling Excellence: The Motorcycle Safety Foundation's Guide to Skills, Knowledge, and Strategies for Riding Right*. It costs about \$25. I have just ordered a copy, ISBN 1-884313-01-9, and I am going to read it.

Bob's Mailbox

Readers of this column may remember the letter from Mike McGinn that appeared in the Sept. 15, 1997 Mailbox. Mike had everything he needed to go trekking with Bob—except a working kidney. So, it is with a great deal of pleasure that we present his most-recent communication.—ED

Hi Bob:

Thanks for the inspiration. On October 20, while recovering from hernia surgery, I got the call I was waiting for. The installation took six hours (which, I understand, is better than NT) and the kidney worked as soon as it was hooked up. I was out of the hospital in 10 days.

I don't know if someone who has not gone through this can appreciate how much it changes your life. Little did I realize how depressed I had become on dialysis, but the fact that I used to go around thinking, "This is my life in hell," should have been a clue. Now my marriage is better, my life is better, and I can do more with my six year old son. It's a whole new life. I can probably even go hiking now, but my strength is not all back yet. It was truly a happy holiday season in my house. We have much to be grateful for.

MIKE McGINN

via e-mail

Mike, we sure hope you can resume vigorous hiking soon. If you're permitted to do it, it's really good for your legs—and your head. Best wishes
—RAP

Dear Bob:

If one more note on prototyping won't kill you, read on...

1. Amusement: Jameco Electronics sells the "Wideband 100-MHz Prototype Board" (catalog 974, p. 84). It consists of the white plug-in-the-leads breadboard inside an aluminum box (7.4 by 5.1 by 1.5 in.) with four BNC connections on two of the ends. I bought one for \$59.95 (don't worry—I don't actually use it!) and have it hanging in my office. I show it to the stu-



dents who come through here and discuss under which conditions you can actually get away with using it. It is amazing how many do not realize how much stray capacitance is built into those white boards. And, I cannot count the number of times I have been told "No, that is a resistor, *not* an inductor," when the resistor is sticking up 1 in. off the board. (Actually, the quality of the proto-board in the Jameco box is pretty good when compared to the Radio Shack version, but 100 MHz??? I'll try to remember to send you the test results next month.)

2. Strange-behavior department: I spent nearly 13 years at Sandia National Laboratories before coming to Kansas State University. I run a department (chief engineer and "pointy-haired boss" rolled into one!) here that supports all of the research groups on campus with custom electronics, sensors, and data acquisition systems. I employ a small full-time staff and about eight EE students part-time. It is nearly the only exposure the students get to "practical" engineering issues.

To their credit, most of them eat it up and recognize the value in and need for this experience. However, I have observed an interesting phenomena here (and at Sandia). The first time a new hardware engineer has to actually build what they design, they go into overload, sometimes for as long as four weeks! Having to specify resistor type, tolerance, wattage, capacitor dielectric, cap. tolerance, cap. package, IC package, heat sink style, connector type (and plug vs. socket), and so on, for a large design overwhelms them.

I even saw a very talented engineer give up hardware and shift to software (surely software has equivalent "loose ends"?) because he couldn't get over it. Then they figure out some ground rules, make some guesses, talk to some old guy and realize that many of the components in a large design just aren't that hard to spec and they move on. Have you ob-

served such behavior?

3. Regarding practical training for engineering students, I don't have an answer, but I sympathize with the engineering schools. A good engineer needs to understand the theory so that they can extend their knowledge to "non-cookbook" situations, but at the same time, they *must* get their hands dirty to see where the theory can be applied. Do I want to spend my life laying out printed circuit boards? No! Did I need to do it a few times so that I really understand the compromises, problems, and gotcha's? Sure did, and because I have a good foundation in theory, I am a better engineer. But most companies are putting a lot of pressure on engineering schools to produce engineers specifically trained for their *current* employment needs. I argue that this is just as bad as producing a theoretician.

4. My favorite prototyping materials are Vector 8007 and 4112-4 boards. They are about 4.5 by 6.5 in., have a ground plane on the top, and various pad patterns on the bottom. I use very short pieces of 24 ga. wire where I cannot use the component leads to interconnect and keep the wire close to the surface of the board. Add standard copper clad to make shields, boxes, etc. The Vector boards work great for through-hole technology, and I have used them (with care) up to about 150 MHz. If memory serves, they are about \$35 each, from Newark and others (not cheap, but very nice to work with).

TIM J. SOBERING

via e-mail

Surely there must be a good way to say "unless noted, all capacitors 0.01μF = ceramic disk type X5U; all resistors are 1% RN55D..." Keep it simple and standard. I have heard of cases where a white solderless board was used to make an experiment that ran up to 100 MHz. But it would be WRONG to count on it. There must be a better way, and you have defined one.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@web team.nsc.com—or:

Address:
Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

What's All This International Business Travel Stuff, Anyhow? (Part II)

As I was saying in my Aug. 4, 1997 column "What's All This International Business Travel Stuff, Anyhow?" I was about to do some international traveling and lecturing. I'd be traveling to South America and Asia, giving a version of the lecture that I had given in more than a dozen places here in the States. And, I wanted to bring an extra set of foils (overhead transparencies) with subtitles translated into the appropriate foreign languages.

The Subtleties of Subtitles? Nobody thought that making up the subtitles was a terribly *bad* idea. But nobody thought it was a terribly *good* idea either.

Folks had never seen them done before.

Most people said, "If you just talk slowly, that will be OK, when you are talking about technical stuff." Of course, part of the problem is that I also talk about nontechnical stuff. But, often the foil on screen helps explain what I am talking about, with drawings, as well as words in the English language. And those words *may or may not* be helpful.

The final decision not to bring a set of subtitles was determined by the amount of help I would have needed to make up the subtitles. Also, there was the weight of the foils—the main

set weighed over 5 lbs for 400 foils. Carrying two more sets in Spanish and in Portuguese would have overloaded my poor little briefcase. I just had better things to do, more important than making subtitles, and I ran out of time. So much for a good theory.

When I was lecturing in Brazil, I just told Rogerio, "If I talk too fast, take off your shoe and throw it at me, to remind me to slow down." But I guess I never did go too fast. I had a lot of fun in Brazil and Argentina. In retrospect, I feel badly that I never went out of my way to talk too fast, and force Rogerio to throw his shoe at me!

Gotta Think Fast! I put on some very good lectures in Argentina and Brazil. In Sao Paulo, we had well over 100 engineers at our big lecture. They all knew how to laugh in the right places! In Buenos Aires, the number of attendees was smaller because the university students had finals that week. It was not that we picked the wrong day; there was no day that week that would have been very good. But, the high quality of the audience made up for the moderate quantity. I got into a spirited conversation with one student who asked, "Mr. Pease, we students cannot breadboard everything. Yet, you tell us we should not trust Spice. What should we do, in reality?"

Good question! I paused and thought about it, and started to build my reply. "For your first or second round of study, there is no harm in using Spice. I prefer to use pencil and paper, but you can use Spice if you prefer. Then when you have a design that Spice says is OK, that would be a good time to build a breadboard, to confirm if and where Spice is telling

you some truth. Suppose you have checked out the performance of the breadboard, and the Spice runs, to get reasonable results or acceptable agreement. Then, when you optimize the final schematic you may be able to easily modify your first breadboard to check out the final version. Does that sound reasonable?"

As we thought about this, I realized I had to tie up loose ends. I suggested, "What if you find a place where Spice does NOT tell the truth? You should document this, as a warning to other students and engineers. Write up a book of such discrepancies." Then I continued to expand these new solutions, "Make up that 'book' on a computer—maybe on intranet at your university—so all students can see it." He agreed this was a pretty good idea.

Maybe all students should keep such a book. Computers are getting pretty cheap these days for storing and disseminating information. That is NOT the same as saying that computers are cost-effective for circuit analysis. I learned a lot from these eager students.

Gotta Have FUN! In that Aug. 1997 column, I mentioned a very good travel book whose name I'd forgotten. The author, Frank Perkins, was kind enough to send me another copy: *Travel Adventures on the Company's Nickel*, ISBN 0-9648512-0-2. I'll recommend this as good reading, especially for people who travel a lot; it might give you some good ideas. If you mention that you read this in "Pease Porridge," you can order it for \$12 from Oak Publishing, Dept. PP, 5225 Crane Rd., Melbourne, FL 32904.

After all, as I mentioned previously, there are times when you might plan to go home as soon as you have finished your overseas work. But if you take a day or two of well-deserved vacation before you come home, you'll be glad you did. I know a couple times I should have, and I regret not doing it. I'll be smarter next time. The cost-benefit ratio is too good not to. I mean, if I am finished with work on a Friday night, should I jump on the first plane home? Or should I spend the weekend in an amazing place, and get on a Sunday night flight? I know the answer to that.

Besides, sometimes staying an extra day or two can save your company a LOT of money on your flight. Ask



BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

your travel agent for advice and guidelines. I often stay over a Saturday night to save \$300 or \$500 or MORE. Air fares are so nonlinear these days!!

Make sure your tax and/or travel experts can tell you about traveling taxes. If you take N days of vacation after N+1 days of work, will you have to pay tax on that, because it's not a business trip? What is your company's policy? More importantly, what is the IRS' policy?

Lecture Time... After I returned home, I had to give a lecture at WESCON. My old friend Jack Leddy had asked me to lecture on a suitable topic about International Business for the IEEE. Of course, I talked about various items we have discussed previously, and much more. I showed them my best check-list for business travel, which is now posted on the web. Go to my web site at: www.national.com/rap and look for LISTS. Or you could go directly to: www.national.com/rap/Lists/0,1150,35,00.html.

At this lecture I gave out a BUSHEL of advice on international travel, such as:

- Be sure to reconfirm your flight. If you do not call the airline after you arrive in a foreign country, they may pretend they have no space for you to return, because you forgot to tell them you would want to go home.

- Be aware of different procedures for stowing your spare batteries, keys, metal, and penknife before you get to the X-ray inspection. In the U.S., putting them in your briefcase is usually OK. But for international travel, put your jack-knife and extra batteries in your *checked* baggage, otherwise, they may be confiscated. However, make sure you do have some good batteries in your camcorder or computer. Security guards often want you to demonstrate that they WORK.

- Inquire about the customer and his problems or complaints before you leave, so you don't walk into a buzzsaw. Insist that you be warned if there are any problems that have been making this customer unhappy. Maybe you can't solve them before you leave, but at least you'll be aware of them.

- Know how to reach colleagues in your home plant or office. Keep a good set of phone numbers, in case

you have to call at an odd time to leave a message.

- Know how to run your e-mail, modem, or voice-mail from overseas. Have at least two phone charge cards.

- Also consider using a telex, a TWX (still in use in some parts of the world), or maybe a video-conference. You might even use the snail mail, international air mail, or an outfit such as DHL, FedEx, or UPS. Some of these are quite expensive, but they could STILL save you a lot of grief and money. In some cases, telephone calls make sense.

- Plan how to communicate before you leave. Know what your customer's expectations are. Nothing annoys me more than a customer who DEMANDS that we send an engineer to his plant, even before he explains the problem. When we get there, it turns out the problem is something we could have solved better and quicker from home.

- Be sure to get good advice on how to make phone calls at reasonable rates. When you are on the road, doing business long distance, you *still* have to be able to communicate. Maybe by modem. Maybe by telephone. You probably already know that hotels like to tack on surcharges of 50% to 200%. On a \$30 phone call, that gets expensive really fast. The pay phone in the lobby is less likely to gouge you.

Eat, Drink, And... What else do you have to do, after you decide to travel? EAT, DRINK, and SURVIVE. (Not a trivial deal.) Find a place to stay. Ride and travel around. Negotiate. Communicate. Travel home. Communicate MORE. All the while, try to avoid making your hosts (or customers) unhappy. And, as I said before, LEARN.

What to drink? In my lecture, I mentioned that, when traveling overseas, you have to drink something, but be careful to not drink too much—unless it's pure water. Drink plenty of water on the plane. Keep well hydrated.

You should also bring iodine tablets or solution, so you can purify the local water. This can work much better than going thirsty, drinking the local water, or buying bottled water. The local water may be legally pure, but the local flora might not agree with your tummy. And, I

wouldn't want to be alarmist, but some bottled water has been found to have enough bacteria to make your insides unhappy. Iodine can help avoid such problems.

Avoid ice cubes, unless you can make your own out of pure water. (But you can always brush your teeth using beer.) In Nepal, our hotel provided large urns of boiled water at each floor, so we could fill our cans with safe water.

One time I went out for a walk with an engineer in a small South-American city. He offered me a treat—some sugar cane juice. The juice vendor fed the big pieces of raw (not TOO dusty) cane through a crusher. The juice ran out of the cane and all over the cane and down through the machine.

I thought about it. Would I dare to insult the customer by refusing to drink this sweet stuff? I decided to risk it, and sipped it down. Not bad. And, I never did get sick. But, if somebody offers you something from conditions that are slightly less than sanitary, you should have a good, *polite* excuse ready: "Oh, my tummy is feeling very wobbly today. Thanks, but, NO thank you."

What To Eat? While we were trekking in Nepal, we were very careful to eat only foods that were safe, on dishes that had been washed scrupulously clean and rinsed with chlorine water. But after the trip, I ate some of the local dhal-bhat (rice with lentils). Why not? The rice has been boiled and the lentils have been boiled; the only way you could get in trouble is if the dishes were not properly washed. But the lunch was very tasty, and I had no problems. Still, I preferred to drink my beer from the bottle, *not* from a glass.

I would never do this, and you shouldn't do it, either: Don't brag, "I like my chilis *REAL* hot!" You might discover that the local restaurants have chilis (or curries) hotter than anything you've ever met in your life! You sure would be embarrassed if you had to be hospitalized.

Remember, curries and chilis are measured, like earthquakes, on an open-ended scale. There is substantially *no limit* of how hot they may be. Or do you want to find out? Do *YOU* want to be a calibrator? Several peo-

ple told me that this happened to one of their friends.

Where To Stay? Perhaps your company's local-office secretary or the customer's secretary can make reservations. Either way, be sure to keep good notes of your reservations and confirmation number. (Not to mention, car rental information.) On more than one occasion, I have moved from hotels that are too fancy and pricey, to digs that are less pretentious. Don't be too surprised if doing that makes you more comfortable—or puts you in a quieter neighborhood. The money saved is probably not as important.

Communicate At Home And Away... In my lecture, I expanded on the ways that even people who do NOT travel, have to be prepared to help and communicate with foreign customers. You never know who will be on the line when your phone rings—could be someone from Ghana, Germany, or Greece. Each business climate has its own customs. No matter if you're traveling or at home, you still have to be able to change gears quickly when that phone rings.

I recommend the great new book: *Kiss, Bow, or Shake Hands* by Morrison, Conaway, and Borden. It covers many areas such as cultural overviews, behavior styles, negotiating techniques, protocol, and business practices in 60 countries.

This book reminds me about many aspects of travel that make a lot of sense, if you happen to think of them. Here are some examples: Don't assume that customs or words that work in one area, work in another. Don't assume that all Spanish is "Spanish." The phrases that work in Spain are often DIFFERENT in Mexico, and even more different in Argentina, even though they all speak "Spanish." If any book purports to teach you "Spanish," a fair question is, "Yes, but WHOSE Spanish?"

The English language also is quite amazing in its variations between the U.S. and England—not to mention Australia or Scotland. Gestures that are OK in one part of the world are often NOT OK in other places. So if you want to avoid insulting your hosts or customers, a book such as this one is very important.

The book also has sections on how to negotiate in each country. I don't

have to tell YOU how to negotiate deals—YOU already know that—but the book reminds us that strategies that work in one country, may be counter-productive in other countries.

The book runs about \$20; ISBN 1-55850-444-3, published by Bob Adams.

Other Books... Other travel books that are very useful are those the *Lonely Planet* series. These can help you travel gracefully in a large number of areas. Any good bookstore can get you the book you want, but in a case like this, I like to look up what is available from Amazon Books at www.amazon.com. It may be easier to tell if you want what they have, on the computer, compared to the trouble you would have at a bookstore.

Now, if you are a starving student, you might want to get most of your travel books from a library. But the first time you waste an hour (not to mention a day) going somewhere recommended by an out-of-date travel book, you'll have wasted more than the cost of a new book, several times over. Students would hate to admit that. But if you are traveling on business, there is no excuse for wasting a lot of time because you're using out-of-date information. (Of course, even the newest book becomes obsolete fairly quickly. You must inquire locally to confirm that what you plan to do is really feasible. There might be a road out, or a boat service that's changed.)

Which Bookstore? Recently I wanted to buy a book on motorcycle safety. I went to a good little book store and asked them to search for it. They could not find it. When I got back to my computer, I searched for it at Amazon Books, and it turned up in 10 seconds flat. So, I ordered it from Amazon.

I do like to do business with real, local book stores. But, if a REAL bookstore is bleating because it is losing business to bookstores on the Internet, it has no leg to stand on when it cannot search for a book properly.

More Lectures... The same week as my WESCON lecture, I was flying to Nepal for our trek. Should I give a lecture there, before I came home? Our international marketing people said it would be a waste of time, because nobody in Nepal is buying many semiconductors. Well, I thought, all the more reason to explain what linear ICs are about. Not

to mention the explanations of, "How to tell when your (digital) computer is lying—and what to do about it."

So I asked some colleagues at Lotus Energy in Kathmandu (they make rechargeable solar-powered systems of all sizes) to get out the publicity, and I hired a hall. We got 80 people to show up. Some were engineers, some were professors at the university. About one-third of the audience were students. Some were technicians or other professionals who work around electronics.

We had a very pleasant evening, on Dec. 5, the day after I got back from my trek, at the Mountain Hotel in Kathmandu. I remembered to talk slowly. The moderator did not have to throw his shoe at me.

Why didn't I give a lecture in India? The international experts thought we would do our best business there by selling microprocessors, for which "only a few lines of software would be required." So they would obviously not need any advice on analog systems or circuits. They decided there would be no point in my giving any lectures in India. Sigh...

On The Way Home... To be sure, it's good if you can write your trip report while you are on the flight home (or, even better, on the drive back from the customer's location), before you forget the important details. Will a 100-MHz Pentium laptop computer be helpful? Maybe, if you can type at faster than 10 MHz. Personally, I prefer a small, laptop word processor such as the Alphasmart Pro, which weighs barely 2 lb, and on which you can type for 60 hours or 128 kbytes, whichever comes first. I bought one for about \$290. The only thing wrong with it is that my wife borrowed it, and she really likes it. She hates to give it back. To find out more about the Alphasmart, call the company at (408) 252-9400, or look up www.alphasmart.com.

What happened to my old Tandy Model 102? I found that its usable memory of 25 kbytes is just too small to be practical for more than a short weekend trip. So, it's basically retired.

Computer Problems... Make sure that your power-line cords can fit into the foreign adapters. Often, a wide prong will not fit in, and you'll have to grind it off with sandpaper or emery

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Your Information Edge

boards. Or a rock. Check that before you leave. (Adapters are available at Radio Shack and many travel stores.)

Make sure you have the correct adapters to run on 220 V. I almost bought a "universal" battery charger, until I read the fine print. It said that it only runs on 115 V! (My Sony battery charger will operate from 115 or 230 V, or anywhere in between.)

Jet Lag? Do you know how to beat jet lag? I like to just take a small nap, when I get tired (which would be the *wrong* time to go to bed for the night). Next, I need a GOOD LOUD alarm clock to wake me up from my nap. Then, I stay up to my ordinary bed-time, good and late. As a result, I wake up in the morning at a good time. This is like hitting a PLL with a big PULSE to force it into lock with a change of phase.

Travel Around... How are you going to get around? In some places you can rent a car, that *you* can drive. (Other places I would not want to.) As I mentioned a couple months ago, in Kathmandu, I hired a good car, with a good driver, for about \$80 a day. Whereas a month earlier, I rented a car at JFK airport in N.Y., and even though I returned it where I got it, they soaked me \$80. Of course, you could always rent a motorcycle... NO, I am NOT serious about that.

How Should I Pay? Know how to use your PLASTIC. I was not able to get cash out of money machines in Buenos Aires, but next year I bet I can get some at the airport. I used to have a four-digit password for my money card. Then, one day, my bank forced everybody to change to a five-digit number. But, in some overseas money machines, only four-digit passwords are accepted. When I complained to my bank about this, they permitted me to change back to a four-digit password. Many restaurants and businesses overseas now accept plastic, but not all. So check before you run up a big bill.

As one of my travel agents likes to point out, "Bring half as much clothing and twice as much money." But I was recently staying in a hotel that charged \$11 to launder a shirt. Fortunately, I had enough shirts to last me to my next city, where laundry rates were much more reasonable. (In Kathmandu, the charge to launder a shirt was about \$0.47.)

When You Have To Go! What's the difference between a hole in the floor, and a toilet? In some parts of the world, not much. To figure out how to attack this problem, consider *Going Abroad—The Bathroom Survival Guide* by Eva Newman. ISBN 0943-400929. About \$13 from Magellan's, (800) 962-4943.

Highway Robbery? When somebody points out, "Sir, look, OH MY! There is mustard all over your coat!" what should you be thinking? You should be EXTREMELY careful because a gang of thieves is trying to distract you, and make off with your wallet or your camera. It's a well-known scheme. Somebody tried it on me, right across from the Sheraton in Buenos Aires.

They did NOT get my camera nor my camcorder nor my wallet. For more information, you might read *Foiling Pickpockets and Bag Snatchers and other Travel-Related Crimes/Scams*. Send a check for \$3.95 to: Travel Companion Exchange, Pickpocket Reprint, Box 833, Amityville, NY 11701. I sent for this a few days ago, but haven't had a chance to read it yet. I wonder if they will include the story of the old Yankee sea captain who kept fish-hooks in his pocket to discomfit pickpockets?

Strange Customs? I'm putting this at the end, but YOU shouldn't do that: Make sure you understand what U.S. Customs says, *before* you leave. Don't buy something that may be illegal or is liable to be confiscated when you return. I hope these ideas will help you survive any overseas trips—and prosper in your international business, too!

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@webteam.nsc.com—or:

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

Circle 550 if you can't get e-mail, and want a copy of RAP's "Business Travel Checklist," by mail.

Circle 551 if you want a copy of RAP's "Maxi-Report" on trekking around Annapurna. (mail or e-mail)

Circle 552 if you might be interested in a VHS format videotape of RAP's 1997 lecture; 3.7 hours; \$15.95.

Bob's Mailbox

Dear Bob:

My old boss (John Myers) stopped by my cubicle a little while ago and dropped the Jan. 12 issue of *ELECTRONIC DESIGN*, open to your column, on my desk. He said, "Gerry, you are in good company with your copper-clad breadboards," and then walked off.

Your column, as always, was good for a chuckle and a lot of whole-hearted agreement. Most of the YPEs (Young Punk Engineers) I have met recently have never had their hands dirty or changed the oil in their car, let alone prototyped.

The bread boards I used to make for John usually consisted of copper-clad stock with a twist. I use a Dremel tool with a mill ball and a straight edge to cut long, wide, bus bars into the copper-clad stock.

By the way, I have used your "What's All This..." title in several of the columns I have done for the Garland Amateur Radio Club. If you want to see them, they can be found at: web2.airmail.net/gerryc/neuham.html. *Gerald Crenshaw*
via e-mail

Gerry, you have some nice work on your site that can help new hams. Sections NHP-4, -3, and -9 seem quite thoughtful. You sure have your head screwed on right! Thanks.—RAP

Dear Bob:

I would like to take a moment to provide my insights (as an EE student) on the notion that there is a slight naivete about passive components. Sure, not every student is taught about differences, but common sense should prevail when looking at data sheets—the material is specified for a reason. Maybe that would give the EE a clue that, quite possibly, one could use other materials for the component.

Maybe not everyone uses data sheets, but that is why the experienced EE can be of great service to the new EE. With a little bit of assistance and encouragement, hopefully



the new EE will become a great asset to the engineering community. So please remember to help the "new kid" and maybe you will feel a little bit better knowing that you are helping your future and someone else's.

MICHAEL ISAACSON
Electronics Design Technician

Nonin Medical Inc.

Plymouth, Minn.

Mike, I agree that we have to be nice and helpful to young engineers. But you'll agree, it's not always easy to get the message across.—RAP

Dear Bob:

Re: Your Jan. 12 column

Seems that these "wonderful" computers have virtually eliminated any lab courses. I remember a chemist friend of mine saying (20 years ago) that soon one would be able to get a degree in chemistry without ever touching a test tube.

At the time, he was programming simulations of titration at the University of Illinois. They were experimenting with computer teaching using plasma displays in combination with rear-screen projection of microfiche.

When I was a few years out of college (circa 1958), I was interviewing new graduates for positions in our company. I had been working on a little logic board, and during an interview, absent-mindedly asked one of the interviewees to pass me a 10-kΩ resistor from the pile laying on the table behind him. I got a blank look in return. "You don't know the resistor color code?" I asked. "No," was the reply. By then, in my early career, I recognized standard 5% resistors without "translating" colors.

Most of my career has been spent at the other end of the frequency spectrum from RF. Presently, I deal with subaudio signals from vibration transducers in balancing machines (5 to 20 Hz, most commonly). We deal with very-low-level signals from vibration transducers, and have learned how to keep our analog circuits quiet. We also

have minimized crosstalk in two signal channels in the presence of high frequencies from the computer that processes the signal after the analog preprocessing.

It's too bad that engineering has gotten so filled with complex theory that there is NO time for anything practical. Back in my college days, we had lab courses in such areas as Welding (gas and arc) and Machine Shop (constructed a nice little bench vice using milling machines, a shaper, and a lathe).

The Mechanical Engineering side course had a lab studying internal combustion engines, dynamometer studies, speed-torque curves, etc.

The Electrical Machinery lab studied motors of various types. Surely most of what I learned in that course is now bordering on the obsolete, but the principles still work. I know the difference in characteristics between series and shunt wound motors, understand capacitor start and run, and single-phase ac motors.

A more recent graduate than I can do a DSP algorithm off the top of his head that sends me to read textbooks and look for cookbook solutions, but he lacks some of the basic understanding of the physics of the real world

RON ANDERSON
Chief Applications Engineer
Hines Industries
Ann Arbor, Mich.

Practical knowledge is so important, because without it, a young engineer can waste a lot of time and get discouraged. It's not easy being a mentor, when the young engineers don't even know what they don't know...The kind of resistor they might have, for example.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@web.team.nsc.com—or:

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

Note: The USA distributor of Wainwright Instruments Inc., whose prototyping system was mentioned in the Jan. 12 issue is: RDI Wainwright, 69 Madison Ave., Telford, PA 18969-1829; (215) 723-4333; fax: (215) 723-4620; e-mail: soldermount@rapdep.com.

What's All This April Fools' Stuff, Anyhow?

It's that time of year again. So I've gathered some more nasty questions to make another April Fools' Column. But first I have to get serious about something for a moment.

Death in the Family: I knew Frank Goodenough for over 30 years, and worked with him for over 12 years. I've sent him many notes in the last eight years—a big envelope every week, as long we have been doing this column. Such a pleasant, enthusiastic guy. I was sure Frank would be around forever. But cancer got him on Friday the 13th of February.

We all need to take good care of ourselves. The next time you men take your annual physical exam, ask your doctor to run the PSA (Prostate Specific Antigen test), to make sure prostate cancer does not sneak up on you. Frank will be remembered

fondly by everyone who had the good fortune of meeting him.

Puzzler 1: Four guys named Ari, Ben, Cal, and Don have to cross a bridge. But the bridge is only strong enough to hold two men at a time. It's dark outside, and they have only one flashlight. If two guys cross using the flashlight, one guy will have to come back carrying the flashlight. (They cannot

throw the flashlight across the bridge.) Ari takes one minute to cross; Ben is slower at two minutes; Cal is slower at five minutes; and Don is very slow at 10 minutes. They all have to make it across in 17 minutes.



BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

This problem is given to Earl and Fran. Earl soon figures out that the best answer is 19 minutes. Fran says she knows the way to get everybody across in 17 minutes. How is that possible? The answer will be published here in two weeks.

Puzzler 2: A couple of my readers pointed out a new "invention" that is supposed to get much higher efficiency from an incandescent light bulb. This invention was published in one of the popular electronics magazines in April of 1997, and the inventor, Steven Rosenberg, has gotten a U.S. patent (5,463,307).

You can visit his web site at members.aol.com/Apsinfo/Apsinfo.html, where you can read the patent, and order a little evaluation kit, to see how great the efficiency really is. Sure, if you use an SCR circuit to *chop* the 115-V ac power going into a little 30-V 50-W light bulb, you can set a very-narrow-pulse duty cycle. You also can establish an average voltage of perhaps 12.3 V (as measured by a dc voltmeter) across the bulb, and an average current of 0.6 A (as measured by a dc ammeter). And the light is as bright as an ordinary 100-W bulb!

Because $12.3 \text{ V} \times 0.6 \text{ A}$ is only 7.4 W, this guy claims that his circuit provides a factor of 10 or 12 more efficiency than ordinary dumb incandescent light bulbs. Why isn't everybody doing this? What's the problem? Check the end of this column for the answer.

Puzzler 3: You folks who have Internet accounts may have read about the "new" ice-water-and-pizza diet. Simply, if one drinks a lot of very cold water, the amount of calories to warm that water up to body temperatures (at the rate of 1 calorie per gram \times $^{\circ}\text{C}$) is almost as great as the calories in the pizza. Did you know that? See my comments at the end of the column for the details on this diet.

Puzzler 4: A couple readers pointed out that a spokesman for Sandia National Labs said that they had designed a long gear train which increased the POWER output from a nano motor, by a factor of over a million (*ELECTRONIC DESIGN*, Jan 26, p. 35). How did they do that?

Puzzler 5: As long as we are tweaking government laboratories, let's not forget the NASA engineer who claims he can get more bandwidth from an amplifier. Leonard Kleinberg has applied for a patent for the invention of connecting a small capacitor across the summing point of an op amp—from the negative input to the positive input. How does this work?

Puzzler 6: The data from my GPS receiver was really not useful in Nepal. It did provide one fun fact, which I figured out when I got home. I had three maps of the Annapurna area. One was grey, drab, and crude, by Mandala. One was very colorful (publisher not identified). And one was German, very crisp and meticulous. When I got back from Nepal, I compared the GPS readings I took at each campsite. When I got to the village of Jagat, the GPS said I was 1.2 mi. east, and 1.3 mi. south of the town—per the map. Did that mean that we were camped outside of town? Or that the GPS readings were **WRONG**? After all, the grey map did agree with the crisp map.

Puzzler 7: Everybody knows why man-hole covers are round. (You DO know that, don't you?) But where can you find man-hole covers that are **NOT** round?

Solution to Puzzler 1: Wait 'til the next issue.

Solution to Puzzler 2: *How about* that 50-W bulb that puts out as much light as a 100-W bulb, with hardly 8 W of input power? Well, the *average voltage* across the bulb may be 12.3 V, and the *average current* may be 0.6 A, but the *average power* is NOT 7.4 W. In fact, the *average power* must be determined by the time integral (over one cycle) of the instantaneous $V \times I$, *not* by just multiplying (average volts) \times (average amperes).

When the duty cycle of a pulsed waveform is very small, the error is *huge*, if you were to just multiply the dc readings together. This measurement error has been so well docu-

mented and debunked that you can look it up on Don Lancaster's web site: www.tinaja.com/muse112.pdf.

This is not a *new* mistake, but a very *old* mistake. I tried explaining this to the "Inventor," but he refused to believe me. He still multiplies the average dc voltage by the average dc current, and insists he has measured the average power. And, he's still selling those evaluation kits.

When I asked him why commercial wattmeters say the bulb is actually using 70 W instead of 7.4 W, he said they are just prejudiced against him, and the power company's wattmeters are in error. He says he can say anything he wants on his web site, no matter what I think—it's a freedom-of-speech issue. Well, if he can say anything he wants—so can I. Especially if I am right...

That little light bulb is actually running not at 8 W, but around 70 W. The efficiency of the bulb IS actually a little higher than that of the ordinary store-bought 100-W bulb that runs on 115 V ac. You can *always* get an incandescent bulb to run with higher efficiency (lumens per watt) by running it too hot, with too much V and I. But then the life of the bulb drops off rapidly, typically with the inverse of the seventh power of the voltage. So, if you need a bulb with high efficiency, go ahead and run it hot. But be prepared to replace it often.

That reminds me: These days, many flashlights do run their bulbs very "hot." This gives you higher efficiency, and more light, for a specified amount of battery drain. But the bulb life is LOUSY. These flashlights have a designed bulb life of only five hours, which is not mentioned at all. So be sure to take one or two spare bulbs on a long trip. I have no objection to the trade-off (improved efficiency vs. poor bulb life). But I consider it unconscionable, that the flashlight makers never warn you about the need to bring spare bulbs.

If you really want to get me on a rant, I'll explain about the Taguchi expert (Phillip Ross) who tells us, in his book *Taguchi Techniques for Quality Engineering*, to beware of flashlights where the bulb burns out too fast—because the manufacturers of batteries make them with such poor quality and tolerance, that the high battery volt-

age burns out the bulb too fast. Don't look now, but flashlight batteries are all made with the same chemistry—zinc and carbon.

Even alkaline batteries have the same voltage, 1.5 to 1.59 V, when new. There is no such problem as "bad quality causing too high voltage on flashlight batteries." But the Taguchi expert wanted us to believe that HE cares more about quality than we do, because he wants to browbeat the battery manufacturers into using higher quality. He didn't even understand that the flashlight bulbs burn out early because they are rated to operate at 2.2 V, but are operated at 2.7 or 2.8 V, for higher efficiency!

Solution for Puzzler 3: About that ice-water diet: Yes, it takes a certain number of calories to warm up the ice water you drink. But this diet relies on the confusion between a "calorie" and a "Calorie," which is actually a kilocalorie. (The calorie, which is short for "gramcalorie," is the amount of energy required to heat 1 g of water 1 °C.) A Calorie, by which all food energy is rated, is the amount of energy required to heat 1 Kilogram of water 1 °C. When we talk about the energy in food, we are likely to use the term calorie, even though we always mean kilocalorie or Calorie. The amount of energy required to warm up a glass of ice water is correctly computed in calories—and thus is 1000 times too small to make much difference in your Calorie intake. If you see this hoax in print, debunk it.

Solution for Puzzler 4: Of course, even though the Sandia guy said that a gear train could increase the output POWER, the editors at *ELECTRONIC DESIGN* shouldn't have printed that statement. Maybe the useful TORQUE or FORCE could have been increased by a factor of 100 or 1000, but surely not the power. And it will be interesting to see what actual output force or torque multiplication can be achieved, allowing for friction, and allowing for the finite strength of a tiny nano-etched silicon gear, before it breaks or binds up.

Solution for Puzzler 5: The NASA engineer, Mr. Kleinberg claims to be able to get more bandwidth, by connecting a small capacitor across the inputs of an op amp. How does this work? Poorly. He applied for a patent on this because nobody else had tried to do

that before. In MOST cases, people avoid adding in such capacitance, because it causes peaking, ringing, and extra output noise. It is not literally untrue that one can cause the 3-dB bandwidth to increase a little—it is just not useful in most cases. If you are going to install a capacitor, you can get increased *useful* bandwidth by installing it across an input resistor.

Solution for Puzzler 6: At Jagat, the GPS readings said that I was 1.2 miles east of town, and 1.3 miles south of the town. Did that mean that I was camped outside of town? Or that the GPS readings were WRONG? No, just because two maps agree, does NOT mean they are right. In this case, the colorful map was (nominally) correct. It agreed with the GPS. It said that Jagat was 40% of the way up from Sange to Chamje. The other maps agreed on 65% of the way. So in Nepal, as elsewhere in the world, maps are not necessarily correct, even if two maps agree!

In a couple years, Nepal will have maps as good as USGS maps, but the good maps have not yet been completed as far west as Annapurna. If you want to see all 22 of our campsites' locations (allowing for ±100 or 200 meters of uncertainty) you can look them up on my web site. NOTE: Even if there is some disagreement with the map, two hikers with GPS receivers should be able to find the same place with better accuracy! If you want to know how to buy the right map, even if it does not have any publisher listed, look in the Trip Report.

Solution for Puzzler 7: Of course, if a manhole cover is round, it cannot fall into the hole. However, in Nashua, N.H. there are still manhole covers that are triangular.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@webteam.nsc.com—or:

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

Circle 550 if you think the answer to Puzzler 1 is 17 minutes.

Circle 551 if you arrive at 5 minutes.

Circle 552 if you took less than 17 minutes to arrive at your answer.

What's All This Floobydust Stuff, Anyhow? (Part 6)

Well, it's time for another assortment of miscellaneous, or what I like to call "Floobydust" topics. But first, let's start with the solution for Puzzler 1 that ran in the last issue.

I'll restate it: Four guys named Ari, Ben, Cal, and Don must cross a bridge, but the bridge can only hold two men at a time. It's dark, and they have only one flashlight, which they must use to cross the bridge. If two guys cross using the flashlight, one guy will have to come back carrying the flashlight. (They cannot *throw* the flashlight across.) Ari takes one minute to cross; Ben is slower at two minutes; Cal is slower at five minutes; and Don is very slow at 10 minutes. Everybody must cross within 17 minutes.

If the fastest walker, Ari, crosses with each of the other three guys, and returns as needed, that will take 19 minutes. How can we beat that? Obviously, if the two slower guys each go across separately, there's 15 minutes shot right there. In order to gain any advantage, we have to get the two slow guys to cross *together*. Now do you see the solution?

First trip: Ari and Ben cross. At the end, Ari and Ben cross again.

In the middle, the two slow guys cross together, thus incurring a minimum penalty. They can cross together because Ari carried the flashlight back (trip two) and left Ben.

After the two slow guys have crossed, Ben carries the flashlight back (trip four) to get Ari. BUT, it does not make any difference if Ari does trip two and Ben does trip four, or vice versa. The total is still 17 minutes. Those are the two solutions. (Jim Ball suggests that Ari can carry each other guy across, taking five minutes total, an elegant rule bender.)

At first, I took about two minutes to work on the puzzle, and I saw the 19-minute solution. I knew I did not have my finger on any 17-minute solution. I then had to get back to work. A few days later I had a few minutes, so I took up the puzzle again, and solved it in three or four minutes. A neat trick. I saw this on the Internet. I'm passing it around not because it is a very hard puzzler, but because it is fun.

My Beetle Dies: I was going to run my 1968 Volkswagen Beetle forever, but it was cruelly murdered by a single steel cable, 3 ft. off the ground, with no flag or warning on it. It wrecked the poor little car's front pillars, bashed in the windshield, and sprung the body—not worth repairing. Fortunately I was only going 4 mph, and only got scratches on four fingers. Not even a bump or scratch on my head. The engine was salvageable, though. The car went to the junkyard at 365,200 mi. It didn't owe me a thing.

So what did I buy to replace it? I was thinking about a good 1968 or '69 Beetle, but I bought a newer car—a clean 1970 Beetle with only 112,000 mi. on it.

GPS Receivers: If you thought that \$400, \$300, \$200, or even \$100 is too much to pay for a GPS receiver, how about \$99.99? Magellan's new Pioneer has some pretty good features at that price. (Call Cabela's at (800) 237-4444, or your favorite retailer.) I'm sure competitors will be right behind.

I got a good Garmin GPS38 model

a year ago for about \$170, and it works fine. It even worked fine in Nepal. And, I do not begrudge the \$70.01 that I "overpaid."

Altimeters: Okay, a GPS machine is not very useful on a trek in Nepal (where the sherpas know exactly where we are camping, and you can hardly get lost, because there isn't a lot of choice as far as trails go). How about a recording altimeter? My wife wanted one for our trek. I thought that bringing an altimeter was a bit silly. But when my wife gives me a solution to the question, "What should I get her for her birthday," I don't argue. We checked out the Avocet Vertechn, a combination watch-altimeter, which costs about \$140. It seemed to have the right features.

Nancy wore it on the trip. Was it a silly thing to bring? Nope. The third day on the trail, I pulled into camp at Dharapani, good and tired. Why? Nancy pointed out that even though we had only ascended from 4300 ft. to 6440 ft.—and climbing 2140 ft. did not sound like a lot of work—actually we had ascended a total of 4300 ft., and descended 2160 ft. No wonder I was a little worn out! So, the recording altimeter can provide a sanity check!

The trek involved starting at 2650 ft. at BesiSahar, ascending to 17,771 ft. at Thorong La, descending to Tatopani at 4200 ft., back up to 9700 ft. at Ghorepani, and down to the road at New Bridge at 3000 ft. That sounds like about 20,600 ft. of rise, and 20,300 ft. of fall. But by the end of the trip, Nancy was able to show that we had actually ascended and descended about 38,000 ft. I was impressed! So I am going to stop being so skeptical about what my wife wants to bring on a trek!

Thermistors: Back in November, I talked about using thermistors over a wide temperature range, such as in your home oven. But who makes thermistors that will cover that wide range? I finally found a data sheet by Keystone Thermometrics located in St. Marys, Penn.; (814) 834-9140. They have one model OVHT(A-1288) that is rated from room temperature up to 500 °C, which is 932 °F, a good safe margin above the 700 °F of a self-cleaning oven.

That's the good news. But are these thermistors inexpensive? The



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In the middle, the two slow guys cross together, thus incurring a minimum penalty. They can cross together because Ari carried the flashlight back (trip two) and left Ben.

bad news is that this thermistor is packaged in stainless steel for good reliability, and thus is NOT cheap. About \$30 in 100's. Also, the gain (logarithmic characteristic) of the thermistor varies by about a factor of 1.8:1, between 50 °C and 250 °C. This is not a serious problem. It would still be fairly easy to make a good oven thermostat using such a device, but it just reminds us that thermistors are not always simple and easy to use, over wide temperature ranges. The thermocouple looks better and better.

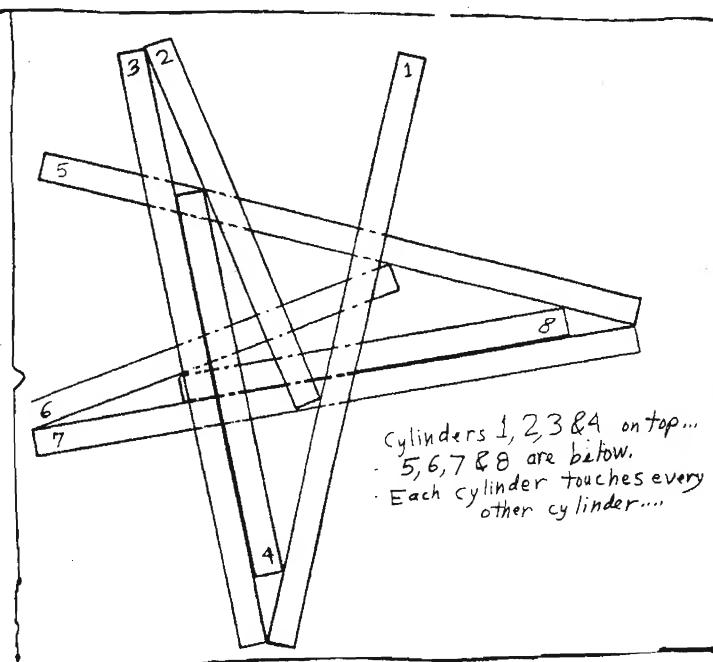
Thermocouples: That reminds me—one guy pointed out that in my November circuit for thermocouples, I showed the thermocouple connected incorrectly, backwards. The *red* lead is NOT positive at hot temperatures. The *yellow* lead is. You would have figured this out, if you had built it. I have labeled this kind of thermocouple correctly in the past.

Other Thermistors: Keystone does make another thermistor, type AUHT(A-1291), that is characterized between 250 °C ($R = 6.01 \text{ M}\Omega$) and 1000 °C ($R = 590 \text{ }\Omega$). That's pretty impressive! Again, the packaging in stainless steel is NOT cheap—about \$40—and it may well be worth it! Do other manufacturers make thermistors rated above 300 °C? I called around and couldn't find a one.

Puzzler Answer: A year ago, I said that you could arrange seven long cylinders so that each one touches the other six. A very small number of readers had the right solution, the same as I did. But one reader came up with a solution of eight cylinders, all the same diameter (*see the figure*). The long cylinders have to be at least as long as about 22 times the diameter, and the shorter ones have to be about 18 times the diameter—they have to be down near 60% of the long ones. And they all do touch! Each of the eight touches the other seven. I like it!

Servo Circuit: A guy named Jerry wished for a circuit to drive a Screw Motor with a Feedback Resistor Servo. The circuit in my Ball-on-Beam Balancer was pretty good (*ELECTRONIC DESIGN ANALOG SUPPLEMENT*, Nov. 20, 1995, p. 50). It never gave me any trouble. Since Jerry did not give me a return address, that's the best advice I can give him.

IC Logos: I got a nice book from Karen Mittelstadt at Sams Publisher: *Component Identifier and Source Book*, by Victor Meeldijk, Prompt Publications (a subsidiary of Sams),



ISBN 0-7906-1088-4, about \$25. It lists all the logos of all IC's made. A useful resource for the library of any big, serious, electronics company. But as several readers pointed out, if you have *IC Master*, you might have a lot of that logo info in there, already.

Epaminandas: After reading my story of Epaminandas, one reader pointed out that you can buy a little book—he searched it out at Amazon Books: *Epaminondas and His Auntie*, by Sara Cone Bryant (*ELECTRONIC DESIGN*, Oct. 23, 1997, p. 151). At about \$12 including tax and shipping, I bought the book. In its 16 pages, it had several drawings of little boys, and about the same story as I told. I think I told it better. Hardly a good investment, unless you are a nut about such stories. But it was amus-

ing to see that it was not out of print.

Books as small as this, with just five pages of text, do not usually get an ISBN number (0-89966-556-x), but this one did. Stories as old as that one do not usually get a 1976 copyright date. But this one did.

One reader upbraided me, because my mother's "abuse" of me (she gave me a whack, which I well deserved, for spilling my milk) caused me to be brutal and abusive to others when I grew up. He claimed I was thus brutal to my children, causing a continuing pattern of brutality. This foolish (and anonymous) writer did not recognize that I plainly stated that when my son tried to pull his glass away, I was careful to not let him spill a drop. I didn't have to whack him. So, Mr. Anonymous, I don't think that a parental swat or spank necessarily constitutes "brutality." I wouldn't buy your theory, even if you had signed your name.

More Speaker Cables: If you want to see some OUTRAGEOUS, preposterous claims about high-end speaker cables, check out these web sites: www.nordost.com and www.cardas.com.

Taguchi: It seems that most Taguchi experts

are not worth wasting your time on. But when Professor T. N. Goh from Singapore University comes to town, I want to see his proposals. He claims he can make Taguchi methods work well. I tend to believe him. (I'm not sure if I should say anything good about Prof. Goh, because I want his success to depend upon what he says, not what I say about him. Still, I want people to attend his lectures. A quandary....)

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@webteam.nsc.com—or:

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PEASE PORRIDGE

BOB PEASE

Bob's Mailbox

Hi Bob:

I've been an EE for some 20 years or so, and a keen biker for slightly longer than that, so your column in the Feb. 9 issue was doubly interesting.

The one thing that puzzles me is the fact that you have sampled the joys of motorcycling, yet aren't going to take it up in what is probably one of the best places on Earth, weather-wise: California.

I think it's true to say that all the bikers I know over here in England are hooked; even a small-capacity bike gives you performance far in excess of any car. I'm not necessarily talking top speed, but how fast you get there.

I've got a 1978 Triumph 750 cc (a pushrod engine based on a bored and stroked 500-cc design of 1938). Although it's pushed to top 100 MPH, it can (or could) get from 0 to 60 in. about five seconds. A line of cars is no obstacle—even in England where we probably have some of the narrowest, most-crowded roads in the world. Just squirt the throttle, and away we go.

I think you should reconsider your decision. I would hate to think of all that beautiful biking weather being wasted.

I'm sure the book you recommended is an excellent basis for safe riding, but the one maxim that has kept me out of trouble (both on bikes and in cars) is to treat the other guy as a jerk. Ninety-nine times out of 100 you'll be proved wrong, but that one time could save your life.

PHIL GEARY

via e-mail

I like to take all sorts of suitable, reasonable risks. The one risk I do not like to take is on a motorcycle. It's too easy for people to ignore you, not see you, or just not care. I'll tell you exactly what it will take to make me buy and ride a motorcycle: it would have to be outfitted with this "accessory"—a laser hologram that looks like a Mack Truck or like a big, rusty Land-Rover. That way, nobody could ignore me. Until then, thanks, but I'll pass.—RAP



Hi Bob:

Good article. Motorcycling can be a lot of fun if it is done safely. Another way to learn is to get a dirt bike, and learn to ride off-road first. You can learn a lot about handling, weight-transfer, and the rest, that way. And it's not so fatal if you fall.

That is how I learned.

A very good piece of advice, that I got from a LA CHP motor officer (a friend), was to drive (on the street) defensively, as if no one else knows you are there. It has worked for me for 31 years. I also agree that riding in traffic is VERY dangerous, especially in a metropolis like the Bay area.

CHRIS LITTLE

via e-mail

Yeah, I always rode bicycles assuming nobody could see me. I only got run down once by a guy making an illegal U-turn in the middle of a bridge. Maybe I should buy a dump truck with a laser hologram of a motorcycle?—RAP

Hi Bob:

I just wanted to tell you how much I've enjoyed your articles over the years. I am an analog impostor, a physicist who enjoyed playing with circuits in the lab, reading books and articles, etc. Fifteen years and many products later, I'm considered an "analog designer" (whatever the heck that means), but I still feel like an impostor. Will I ever get over this?

BARRY McGINLEY

via e-mail

Barry—are you trying to say that you might have a guilty conscience because you are getting PAID for having FUN? Well, don't feel too bad about it. I get paid for having fun, too.—RAP

All for now. / Comments invited!

RAP / Robert A. Pease / Engineer
rap@web.team.nsc.com—or:

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

What's All This Soakage Stuff, Anyhow?

Of course, this column is going to be talking about the *Dielectric Absorption* of capacitors. But that is much too long a phrase, so we'll call it soakage, or DA. The earliest manifestation of DA was found when old experimenters had a capacitor such as a Leyden jar (a glass jar with metal foil electrodes inside and out) charged up to a large number of volts. They knew if they shorted out the capacitor, the charge would go away. But if they shorted out the capacitor for only a short time, the voltage would recover.

For example, if a 2000-V, 0.1 μ F capacitor was discharged through 220 k Ω for just 20 seconds, you would expect it to be well discharged. So, if you came back a few minutes later and got a really big jolt from that capacitor, you would be surprised. This was well known as

early as the 1700s, and was documented 100 years ago as "residual charge," in my 1894 *Encyclopedia Britannica*.

In the early 1900s, the theory of dielectrics provided a fairly good explanation of how the molecules were slowly polarized to store charge—and how they were slow to let loose of their polarization when the original voltage was removed. All capacitors have some DA, but there

BOB PEASE

OBTAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

are many octaves of relative goodness (or badness). When you have filled up the capacitor with charge, after you try to short that charge out, the *soakage* charge just keeps coming out of the capacitor. (Of

course, if you thought you had charged a capacitor up to a new value, it would take a while before it stopped needing extra charge. Soakage is a fairly linear effect: It's just as hard to charge a capacitor *up* as it is to charge it *down*.)

The original definitions of DA were only spelled out in terms of hours. If you charge up a capacitor for an hour, then discharge it for a minute, and come back an hour later, what is the voltage? The oil-filled capacitor used in the high-voltage power supplies of old radios, was pretty bad—as much as a 20% voltage error. That's a lot of hidden charge. But many good capacitor materials such as polystyrene were 100 times better than that. So, you didn't have to accept 20% errors. A darned good thing!

Where is a practical example of where soakage is important? Well, if you turn your color TV off and open up the back, what's the first thing you have to do before you start working on it? Put a grounding strap on a screwdriver and reach under the rubber shroud on the HV plug to discharge the CRT. OK, now that capacitance has been discharged, how much voltage will "soak" back into the "capacitance" of the picture tube if you let it sit for about 10 minutes? Enough to make a *visible arc* when you discharge it the *SECOND* time...now that's what I call dielectric absorption. So, you don't want to fool around with a real high-voltage capacitor, if it has only been discharged once.

Still, if you know what happens every time you charge up a capacitor for an hour, how can you tell what will happen when you charge it up for one second, or a millisecond, or 10 microseconds? This isn't obvious.

The model for a capacitor with soakage is a big capacitor, in parallel with several small capacitors in series with various large resistors (*see the figure*). If we put a dc voltage on the capacitor for 0.1 second, some of those smaller ca-

pacitors will be charged up, but some of the bigger ones will take more time.

Back in the 1960s, I fooled around with some rather good capacitors, and a few mediocre ones. At Philbrick, I made some very good integrators. I started with teflon capacitors, and FET switches to reset the integrator after it had been integrating for a while. We had several different reset circuits and sample-and-hold circuits.

The fun circuit for resetting your integrator was an old circuit from the early 1950s, that used vacuum tubes and a neon lamp. When you wanted to reset the integrator, a pentode was turned on, and a small RF oscillator started up. The output of the oscillator was fed to a wire wrapped around an NE-2 neon lamp. Presumably the neon lamp was induced into conductance, went to low impedance, and reset the integrator. I have never built this up, but maybe I'll do it. I wonder if it works well at all. But, I suspect, not.

When the integrator was reset, the main capacitance was shorted out. Some of the faster RC networks would be discharged, but the slower ones would cause significant errors. So I engineered some compensator networks to compensate out, cancel that charge.

I have a pretty good write-up on my web pages. There, I wrote that nobody ever talks about soakage or dielectric absorption in any detail. Recently I received letters and e-mails from readers, one of which pointed out that *The Art of Electronics*, by Horowitz and Hill, has a neat little explanation of DA.

I tried looking it up in that book (the original 1980 edition), and I nearly went blind looking for it. Nothing in there. Finally I got suspicious and went to our library, to look in the second edition (1989). OK, there is some mention there, but they don't say much quantitative about soakage. Then other people wrote to me, pointing out some of the seminal work in the field, by Paul C. Dow, Jr., in 1958, and Robert Guyton and Joe McKay in 1968.

Dow, in the *IRE Transactions on Electronic Computers* (analog computers, in those days, of course), March 1958, pp. 17-22, measured the soakage of the best capacitors of the day—polystyrene. His data resulted from measuring the current flowing out of a capacitor after it had been charged for a long time, and discharged for a short time. His

model of the soakage showed that a basic 1- μ F polystyrene capacitor might appear to have a series RC network across it, such as 140 pF in series with 3.5 Mega Megohms (MM Ω), a 200 pF in series with 250 kiloMegohms (kM Ω), a 270 pF in series with 20 kM Ω , a 190 pF in series with 3 kM Ω , and another of 120 pF in series with 330 M Ω . (Figure 4 at my web site is quite comparable, but the losses are worse because it's a model for a mylar capacitor.) Dow indicated how much trouble these RC networks would cause for various analog-computer and integrator circuits, such as unwanted phase shifts and errors when making an oscillator out of a couple integrators.

But Dow looked at the soakage in time-frames from 1000 seconds to just 0.1 second. Hey, it's a fact that the official definition of dielectric absorption requires a capacitor to be charged up for 10 minutes, discharged for 1 minute, and then monitored for another 10 minutes. But that doesn't tell you much about how your sample-and-hold circuit will "distort" if you're looking at a small signal just 10 or 1 ms after it was discharged from a large voltage!

So, in my studies, I ran charge and discharge times from 100 seconds down to 100 μ s. You can look at the characteristics of various different types. I must admit, I did run all of my tests with a TCHARGE:TDISCHARGE of about 10:1. But the results over wide dynamic ranges showed that the accuracy of a sample-and-hold capacitor tends to get better as you go faster.

The other guys—Guyton at Mississippi State University, and McKay at Redstone Arsenal—engineered a compensating network for an integrator, to make it closer to perfection. However, while their integrator did have greatly improved phase and amplitude errors during integration, their compensation circuit wouldn't help in trying to reset the integrator to zero quickly. It only worked by changing the phase shift of the input resistor to compensate for the phase and gain errors in the capacitor. If you wanted to short out the capacitor, to reset the integrator, their paper provided no help at all.

The circuits in my tech paper show how you can get good, quick settling from capacitors in integrators or sample-and-hold circuits, where you need fast reset action. Where is that web site? It's at www.national.com/rap.

Then, at the bottom of my home page, click on the "good technical stuff." It's one of three papers there. If you can't get on the web, write me a letter, and I'll send you a copy of that paper.

Can you hear the advantage of low-soakage capacitors in your hi-fi amplifier? Lots of experts say "yes" ... those golden-ears again. If an amplifier is "capped" by taking all electrolytic capacitors out of the signal path, and replacing them with good film capacitors, it has to sound better. All the experts say it sounds better.

Tom Nousaine (who did ABX testing on speaker cables) says the golden-ears cannot hear a difference, in truly blind tests. I believe him. Of course, that does not mean that there are no differences. Nousaine is careful, after all, not to leave all the controls "flat," because this might let out all sorts of differences in frequency response. He makes sure that the gains of both amplifiers are matched within 0.1 dB at 0.1, 1, and 10 kHz. If one did not do that, one might hear a difference.

Now, that does NOT mean we can't hear the effects of a tantalum capacitor in a poorly-designed circuit, with improper bias. I'll run some tests on those, soon. But it's well-known that tantalum caps can sound pretty weird if they are ever allowed to get biased the wrong way during part of a cycle. I bet even I can hear that kind of distortion.

I heard a great story about some extreme tests on capacitors. The engineers took a 1- μ F mylar cap and charged it up to its rated voltage, say 50 V. Then, they heated it to 150 °C, for a while, afterward cooling it down to room temperature, still maintaining 50 V. Next, they shorted out the capacitor and measured the charge. Of course, they got 50 μ C, or $Q = C \times V$. That's what you'd expect.

Then, they held the capacitor at 0 V,

and heated it back up to 150 °C. The amount of charge that flowed out of the cap, as it was heated, was larger than 50 μ C! Of course, 150 °C is considerably outside of the normal working range for mylar capacitors, but it did not cause any problems, other than this huge amount of residual charge stored on the molecules of the dielectric!

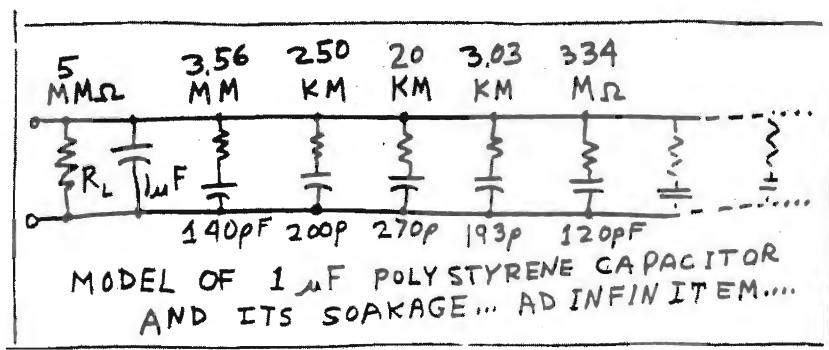
Recently I read an e-mail from an old friend, who said that one web expert asserted that speaker cables made with low-soakage materials will sound better than cables made with high-soakage insulation. He claimed that since Pease explained how soakage works, the better cables must sound better. My friend asked me if there would be any audible difference.

I thought about it, and I reached into my wallet. I've been carrying around a photocopy of some facts about different types of speaker cables for many months. I don't think I carried them the 200 mi. around Annapurna, but other than that, I've been carrying them for over a year.

Let's assume we are talking about 10 yd. of cable; anything less than that would be sub-negligible. Some of the simple, low-capacitance ones have 10 to 30 pF/ft. Some of the good, low-impedance ones, which I like (made of 32 pairs of wires), have as much as 300 to 700 pF/ft., or 9000 pF to 21,000 pF/30 ft. Let's talk about those.

If you used a 30-ft. length of cable as the storage capacitor in a sample-and-hold circuit, a teflon cable would look pretty good. And the cheap rubber or plastic-insulated cable might make a rather poor sample-and-hold. A 20,000-pF capacitor made of teflon-insulated wire might have, at 1 or 2 kHz, as much as 20 pF in series with 8 M Ω .

A cable made with poor plastic might have 50 times worse than this, such as 1000 pF in series with 160 k Ω . Mind



PEASE PORRIDGE

BOB PEASE

you, I have not yet measured *lamp cord*, as a hold-capacitor in a sample-and-hold, but still, this is a ball-park worst-case kind of soakage. Let's see where this leads us.

If you measure the loss factor and settling tails of a sample-and-hold circuit, due to the resistance, the poor cable might look a LOT different. Now, take this poor, lossy cable out of the sample-and-hold, and connect it to an 8Ω load. Then, drive it from an audio amplifier with 1Ω of output impedance. If you put $160\text{ k}\Omega$ across 8Ω , it would definitely make a tiny, but measurable difference in impedance—perhaps 0.005%, or 0.0005 dB. It would be different from a teflon cable, all other things being equal. But not a heck of a lot. And, if you consider that the low-impedance amplifier (1Ω) is driving this $160\text{ k}\Omega$ in parallel with the 8Ω , that would sound like a 0.00005-dB warpage of the frequency response. I would not call that audible.

So, I replied to my concerned friend, that the "expert" who thinks that speaker cables will sound "different" or "better" if they are made with low-DA materials, will probably have a very thin chance of telling any difference.

I told him this relevant esaeP's Fable: Do you know the Celluloid Cat? That is the Celluloid Cat being chased by the Asbestos Dog. Well, that "expert" has about as good of a chance of hearing any difference, as the Celluloid Cat being chased by the Asbestos Dog through the Fires of Hell.

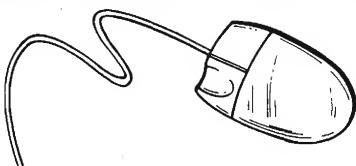
In the week after this analysis, I came across two other cases where the parable of the Celluloid Cat came up, because it was a perfectly applicable case. I figured, three times in a row, that it was trying to tell me something. So here is that fable. NOTE, to young kids and people who cannot remember back 40 years, photographic film and ping-pong balls used to be made from celluloid, and they were REALLY flammable. These days, they are NOT made of celluloid, and not very flammable.

All for now. / Comments invited!
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rap@webteam.nsc.com—or:

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Bob's Mailbox

Dear Bob:

I've been following the technique of breadboarding with copper clad. I have used the Moto-tool approach to cut between the traces, but I think I have an easier way. I noticed that merely scoring the copper with a knife and a straight edge is enough to allow it to be pulled away from the board. So, I soldered two utility knife blades together so that they would both cut at the same time. Now, when installed in the utility handle, they make two neat, parallel cuts 20 mils apart that can be pulled away easily with an X-ACTO knife. Thinking that 20 mils might be small for my purposes, I tried grinding off the cutting edge of another blade to use as a spacer. Now the three-blade sandwich makes a 40-mil line.

JIM PHILLIPS

via e-mail

Hey, Jim, I'll have to try that. I am not sure it's much faster than just using a hacksaw to cut a line. But it sure will make L-shaped cuts better than a hacksaw can!—RAP

Dear Bob:

I, too, have seen the ice-water and pizza diet floating around the net, and tried to debunk it. Interestingly, I came on the same thing a long time ago (mid-1950s) when I was a kid. You see, I like soft drinks with "lots" of ice, and my mother complained about the number of calories they contained. I calculated about how much energy it took to raise the water to body temperature (including the latent heat of melting). And, yes, I did understand the difference between calories and kilocalories, even then, at about 10. It really did make a difference of about one-third in the number of calories—if you fix drinks the way I do. I don't know if my mother ever bought the calculation, though.

By the way, there is another reason why manhole covers are round besides keeping them from falling into the hole. You can move them by rolling, which is harder, though not impossible, with triangular covers.



BRUCE WALKER

via e-mail

In many places, rolling a manhole cover may not be a big deal, but in other cases, it's a distinctly neat feature. Thanks for pointing this out.—RAP

Dear Bob:

This is in regard to your International Travel column in the March 9, issue. I recently returned from four months in Turkey. I didn't trust the tap water, but realized bottled water would be very expensive. I took along iodine tablets for emergencies, but for regular drinking water I used a camper's micropore filter, and filtered the tap water in my apartment. It was a lot cheaper than bottled water.

I was going as a visiting professor, and knew I'd also be giving some seminars. Taking along all my overhead slides would have been a horrible burden. Instead, I saved my slides as PowerPoint files on a ZIP drive. Once there, I was able to print them out on transparencies. On one occasion, I had to give a briefing to the Turkish Department of Defense. One of my colleagues translated my slides into Turkish, and in effect, we gave two briefings in parallel. We showed both sets of slides at the same time. I would say a few words in English, and my colleague would then repeat what I said in Turkish. It worked out fairly well, but not as well as speaking directly to the audience.

JOE MARTINO

via e-mail

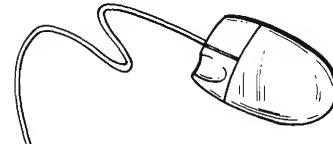
You are correct that the water filter is a wise third option. I should have mentioned that. AHA! You've run the double-foil presentation and it seemed to work! I'm glad to hear that.—RAP

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What's All This Obsession Stuff, Anyhow?



Anybody who has seen my nation-wide lecture knows that, at the start of my lecture, just after I ask a couple mathematical questions, I ask the audience, "How many of you wake up in the morning with a song going around in your head?" Last night when I asked this question, only two guys out of 40 held up their hands. But often, one-quarter of the audience holds up their hands. As I mentioned in my "Aptitudes Stuff" (see *Electronic Design*, Nov. 3, 1997, p. 219), I have a good "memory for pitch." I can still remember the first three songs I ever learned in the third grade. Soprano AND alto parts. But maybe not all the words.

A few years ago, for a whole month, I woke up in the morning with Paul Simon's "Mother and Child Reunion" in my head. I really didn't need that in my head, but that's not a bad song. I recall that it was written about the reunion of a chicken and an egg, in a chicken omelette. It's a catchy song with catchy rhythms—Caribbean or Calypso beat.

One time I was backpacking up at Snow Mountain, Calif. I woke up with a bad headache, plus the James Brown song, "I Feel Good" going around in my head. I definitely did NOT feel good, and I knew that song, which I had heard the previous day on the radio, was going to be stuck in my head for hours. Boy, I felt awful.

But fortunately, within an hour, a miraculous shift happened, and "The Big Brass Band From Brazil" came into my head, replacing the other song. I felt a lot better. "Oh, they practiced all night long, But they only knew one song. That was all they ever played, In 87 different ways. Oom-pa-pa, figaroo, the Big Brass Band From Brazil." The third line is probably wrong, but I remember the other lines perfectly after 40 years; I did NOT hear or learn this recently. Anyhow, now, whenever "I Feel Good" comes on the radio, I turn it off promptly, so it does not get stuck in my head.

Right now, there is a song going around in my head. I will NOT tell you exactly which one it is. I'll let you figure out which one you like, from this selection.

I was asked to attend a little performance, in Felton, Calif., about a year ago, by my previous roommate (from 1960, the year before I got married). One of his kids was singing in a group. I drove down to Felton, open-minded. Might be good, might be—who knows?

Now, there is some music that "grows on you;" some music is just like that. If you hear it several times, and you do not like it much, but then—after several hearings—you might decide you like it. The first 12 times I listened to the album, "Fleetwood Mac," back in '76, I was not impressed. Finally I figured out that I liked "I'm So Afraid." To get to this song, I had to listen to all the rest of the record, and I got to like the other songs, too. A lot. But the first 15 times I heard them, most of them were not my idea of fun.

But, when I first heard the group, Babes With Axes, I was instantly impressed, "knocked out." Some of their songs made me laugh—right away. Some of their songs made me cry—right away. No long break-in period. I bought a couple of their CDs. I listened to them many times, and I still like their music. I don't think you will have to listen to their songs 10 or 20 times to find that you like them. And, after you listen 10 or 20 times, I don't think you will decide that you do not like them.

So now I am going to recommend to you to buy their CD, "Live Axe." If you just send \$15.00 to the Babes With Axes (BWA), you can get their CD. I am recommending to every one of my readers, that you start throwing dollars into an envelope marked: BWA LIVE AXE, P. O. Box 12178, Eugene, OR, 97440. When the money gets up to \$15.00, send the money (or check) to the band. Make out the check to Debbie Diedrich.

When it arrives, listen to the CD. Yes, I know, a CD uses digital technology (more on this another day). Yeah, I know, I am a big skeptic of digital stuff, but it is OK. Really. Trust me on this. You may not be impressed with every song, but you'll find some that you like a lot.

PEASE PORRIDGE

BOB PEASE

Why BWA? I don't know, but these four women—Laura Kemp, Debbie Diedrich, Katie Henry, and T. R. Kelley—write all their own songs, and they sing and play all kinds of guitars (in the music business, a guitar is an axe). And, they are a little crazy, and their music is quite enjoyable. Besides, this music has been running around in my head for many months, and I have to recommend it.

Who should NOT buy this CD? People who don't have a CD player. Do they sell a tape of this? No. If you really cannot stand any guitar music, I'll let you pass. They have a couple other tapes or CDs, and they have a web site. If you can hear audio from your computer (I cannot) there are a few minutes of good audio that you can access there: http://www.efn.org/~gordon_k/babes.html.

I think we should encourage a LOT of young women (and men) to take up music, seriously, just in case some of them might turn out as talented as the Babes With Axes.

Have I ever told you the milk-bottle story? In my office I keep an old-fashioned glass milk bottle. It's only half full of tears. Whenever anybody comes and tells me some kind of a sad story, I pass them the milk-bottle, and tell them, "When you fill up this bottle with your tears, come back and tell me." My milk-bottle at home is half-full from tears, listening to the songs on BWA's "Live Axe."

By the way, I just tidied up the big stack of Electronic Design magazines that extends from my very first column that began in September 1990, to now, in my back room. The stack of 187 magazines is 54-in. wide. And it weighs 139.5 lbs. I'm impressed. Can I carry 139.5 lbs? Yes, probably. But, not very far.

I received some good video footage that my friend John Cordes took, on our recent trek. I tried to pick up a porter's load of about 80 lb. John had his camcorder running, and he was saying, "Bob is going nowhere"—that load is too heavy for this mere gringo to pick up. But I got the load onto my back, using just the standard tump-line, and stood up. I carried that load, and walked a few hundred yards down the hill, which astounded all the trekkers. And, I impressed the porters, too. They said, "Wa, wa, wa..."

Did I pick up this 80-lb load unassisted? Not quite. In that case, the tape shows that the porters did help a little. But their help was not really necessary. How much of load can I pick up, unassisted? Over 90 lb? Sure. I'll prove it, one of these days. Can I carry 139 lb? Safely? Sure. No problem. I'm not sure I could get it off the ground, but we shall see.

The picture of RAP at the front end of each column, has been printed about 33 million times. If an optimistic 9% of you readers have saved my columns, then my picture has been trashed 30 million times. How many of you have had a picture of your mug, thrown away 30 million times?

But, don't just sit there. Go over and get a 32-cent stamp, and put it on that envelope, and put on that address, BWA, P.O. Box 12178, Eugene, OR 97440.

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Bob's Mailbox

Dear Bob:

I want to take advantage of this occasion to tell you my experience with Fuzzy Logic. I am in charge of an R&D department where we develop spark erosion generators. Our company manufactures electrical discharge machining (EDM) tools.

As you might know, these machines are used to form a negative shape in a very hard metal (carbide or hardened steel), starting from a graphite or copper electrode (easy to machine), or using a traveling wire as a cutting electrode. We apply a voltage between the electrode and the workpiece, in a dielectric oil bath. As soon as the current flows, a plasma channel builds up, and spark by spark, we machine the workpiece, leaving the electrode almost intact. The result is a mold, die, or punch to manufacture almost anything and everything.

Every object made of plastic, and many made of metal come from this process, e.g.: cellular phones, TV sets, connectors, coins, microstructures, integrated-circuit lead frames, surgical tools, almost every automotive part, fuel-injection nozzles, turbine blades, etc. The EDM process is a nightmare to control. One has to control the gap width (the distance between the electrode and the workpiece) very tightly, otherwise the process degenerates into an arc, damaging the electrode, and burning the oil—and eventually the factory. The energy density involved is very high, typically 10^5 to 10^7 W/mm²; therefore we have less than 1 ms to control the gap width.

The process is rather slow (typically 10 to 500 mm³/min. stock removal). Therefore, it is very important to use good process control, to maximize the machining speed. So, usually several parameters are controlled at the same time (gap-width setpoint value, pulse frequency, pulse shape, voltage, current, flushing, etc.).

To make things worse, in spite of several efforts (Texas A & M University, Technical University Aachen) to



build a process model, we still have no useful macroscopic model to apply in the control system. Due to the always-changing local geometry, the EDM process is highly nonlinear, stochastic, and non-stationary.

In 1993 we thought about using Fuzzy Logic to control the EDM process, in absence of better methods. Up to that time, we had been using analog controllers, then digital ones, utilizing the Ziegler Nichols criterium to approximate the PID coefficients. (Better than nothing.)

This kind of controller worked OK, but the Fuzzy system, after about six months of optimization, gave better results. In the most difficult machining, we could improve the speed by 20% to 200%. This is probably because we used rules that came from the experience of our skilled operators to fine-tune the Fuzzy rule base, according to the machining context, i.e.: roughing, finishing in a deep cavity, bad flushing conditions, etc.

Since then we have sold about 2000 EDM machines that perform the most varied and difficult machining tasks, and we can conclude that in our case, Fuzzy Logic helped us to improve the process control. Having said this, I agree with you that in most cases, Fuzzy Logic is not better than a properly-designed traditional controller, and I never use it if there is an alternative.

MARCO BOCCADORO

via e-mail

My congratulations to you, Mr. Boccadoro! It sounds like you have used Fuzzy Logic (FL) to solve some serious nonlinear problems. As I suspected all along, when the problems are very nonlinear, and no mathematical models have been found—maybe if you work really HARD, using FL, you can get the advantages that FL provides—which is completely different than just saying “FL is easy to do.”

I bet that team of engineers that worked six months to get it to work well, did not think it was “easy.” I am also pleased to note your observations

that working experience in such a process is valuable to get the FL controller to work well. Mindless promoters of FL who say that you do not have to know anything about the process are just foolish. I’m delighted to publish your letter, as a sanity-check on FL. Note that a U.S. Patent has been issued on this technology. Great work!

—RAP

All for now. / Comments invited!

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P. S. There are a couple loose ends to tie up on the 1-MHz VFC Analog Supplement column packaged with this issue. I neglected to mention the nonlinearity I observed. After I put in the LM741 buffer, the linearity was about 5 ppm of Full Scale PLUS about 0.03% of signal. Thus, at 5.00000 V, F was about 500,150 Hz, referred to 1,000,000 Hz at 10.00000 volts.

I could get the tempco down to about 40 ppm/°C by shunting down the 3-kΩ resistor listed at “Tempco Trim.” I should mention that the critical 50 pF capacitor (in series with 1 kΩ) was a silver-mica, which typically has 50 ppm/°C. You could use an NPO or COG ceramic for fairly similar results. Can I invent a trick circuit to improve the linearity even further? Yeah, I could probably feed a small fraction of V_{IN} , into the input of the LM741. Ask me for details.

And there was one minor goof in the published schematic. If you want to put in a negative input signal, through the 10-kΩ pot and the 40-kΩ resistor, this works fine, as shown. But if you want to put in a positive V_{IN} , then you have to add a 4.02 kΩ resistor to ground, from the negative input of the first amplifier, to get the correct gain and scaling. The original hand-drawn schematic had this 4.02 kΩ, and the actual circuit had this resistor built in, but I did not check the computerized schematic closely enough, until an hour after the column went to press. Just goes to show how checking is not easy. If I had taken a red pencil and checked off each item on old and new schematics, I would have noticed the discrepancy. Sorry. /rap

What's All This Circuits-In-Your-Car Stuff, Anyhow?

Hip, hip, hooray. Pease is *finally* going to talk about electronic circuits. So many of these recent columns have been about things that have nothing to do with electronics. True...Sorry about that. Well, I have been designing lots of circuits, but a lot of them I can't talk about. I can't talk about a circuit we are developing and planning to sell. I can't talk about circuits that we are patenting. There's lots of things that I can't very well talk about. But these circuits here are NOT confidential. You might call them chicken-manure circuits, but they do work OK. They are useful, and not completely obvious. I have never seen them in print. Even though these circuits are not very sophisticated, if applied in a useful way, they can be very valuable.



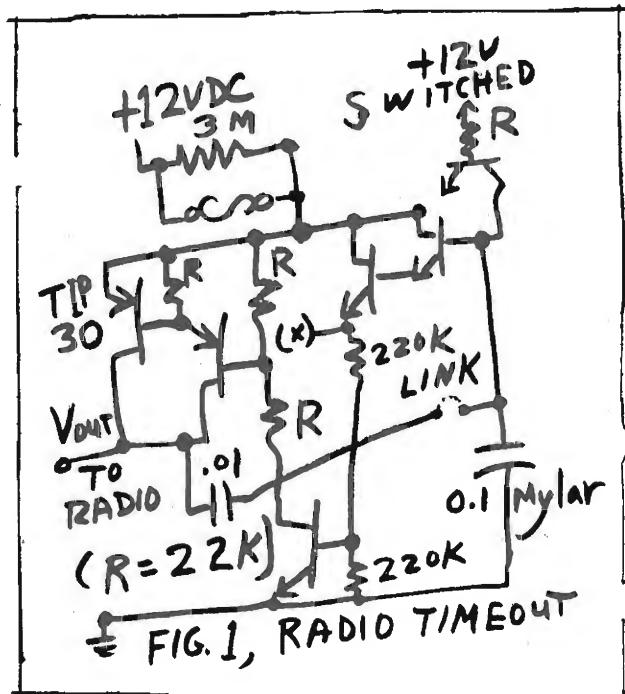
BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCTOR CORP.,
SANTA CLARA,
CALIF.

Just one caution: if you are trying to search at the U.S. Patent Office to find out the patents of an inventor, and type in: IN/"Jones Jr.; John."—you can't find anything, even if "John Jones Jr." has a patent. Their search

cuits I am putting in my "new" car. These days, there are microprocessors and circuits everywhere, in most new cars. That is probably half the reason I prefer to buy a not-so-new car. Some guys have asked me, "How can I protect my car so it will not be disabled by an ElectroMagnetic Pulse?" I tell them it's easy—just buy an old car.

Chimes: I am always amused when I rent a car with chimes. I don't want to

BUY one, or to OWN one, but it's fun to drive one, for a change. Some cars have chimes to warn if you are leaving your keys in the car when you open the door. Or if you leave your directional signals blinking absent-mindedly for too long. I am always reminded of the story of the man who gave out an awful belch. A very proper lady nearby was horrified, and she said so. He responded, "Exactly what were you expecting? Chimes?" Modern cars have circuits to turn chimes and lights

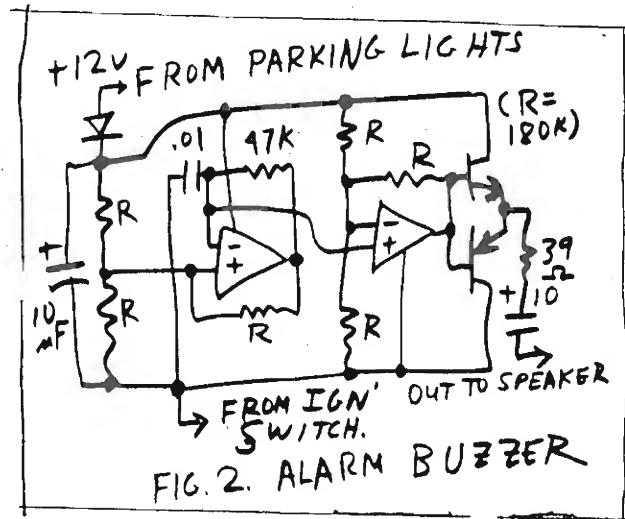


engine can drive you wild. You have to type in a comma after Jones, and then they will lead you to the patent.

But, today I will talk about the cir-

on and off, circuits to run your ignition and your fuel injection, and 999 other things. Some high-end cars have dozens and dozens of 'processors'... but not the one I just bought (a relatively new, 1970 VW Beetle).

I got a radio. I think it has eight transistors. It doesn't run very well. Flakey. I'm gonna rip it out and put in one that has 10 transistors. I got ignition points that open every time I need to fire a spark plug. I got a coil. I got a horn. I got lights. I got electricity.



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So, what *electronic* circuits am I going to add to my latest car? Look for a horn-rattler, alarms, reminders, timers, radio turn-off, etc.

Radio turn-off: Sometimes I like to sit in my car and listen to the radio, with the ignition off. But I don't like to just leave the +12-V dc power on permanently for the radio because it could easily run the battery down, if I forget to turn it off. So, I put in a timer that turns the radio off a couple minutes after the key is turned off.

Refer to the circuit in Figure 1. I have built about four versions of this circuit, for various cars. It works OK for me. So, I just built another one for my new red Beetle. Hey, I never had a red Beetle before.

How does it work? When the ignition is ON, the transistor at the upper right acts as a diode and keeps the 0.1- μ F cap charged up. All the transistors are turned ON. When the ignition is turned OFF, that capacitor is discharged down in a couple minutes, by the base current of the transistors—perhaps 5 or 10 nA. When the voltage on the cap gets low enough, all the transistors turn off, and the radio turns off. The positive-feedback capacitor (0.01 μ F) is optional.

Maybe this time I'll build it without that, to minimize the *click*. No, I will solder in the capacitor on one end, but I won't connect it—so I can easily change my mind.

When I built this circuit in June, the shut-down time was more than 10 minutes, so I had to put a 27-k Ω resistor from the emitter of the Darlington, at "x," to ground, to get the delay near three minutes. The NPN betas were too high.

I've built this basic circuit with a PNP Darlington output driver, and a PNP-NPN, and a big Germanium PNP that came out of a Minuteman I nose-cone. Most of these schemes have an ON voltage of about 0.9 V at 1 A, and that's OK with me. If I needed a better switch, with lower ON voltage, I could drive the gate of an N-channel MOSFET to +23 V. But, since that is not a big deal, I've never done it.

The "3-M Ω resistor" is just a place where I solder up a single strand from a stranded wire, to act as a fuse. If the fuse blows, I'd swap in another 3-M Ω resistor—with a new strand.

Of course, in all these circuits, *unless otherwise noted*, NPNs are 2N3904 or similar; PNPs are 2N3906 or similar; resistors are $\pm 10\%$, and diodes are 1N914/1N4148.

Headlight reminder buzzer: See Figure 2. It is so easy to turn on your headlights or parking lights and forget to turn them off, that I really need this buzzer. On a rainy day, it is a **VERY** good idea to turn your headlights ON. But it is also a good idea to turn them OFF. I just connect this circuit between a parking-light fuse and the ignition switch. So, if the lights are left on when the ignition is turned off, I will be reminded.

I like to make this a 1.5-kHz triangle wave, so if I have to leave my lights on, the buzzer will not annoy me to death. I typically feed this signal into one of my car's speakers, through 39 Ω in series with 10 μ F.

Burglar alarm, Mode I: Type this up and print it out, and tape it to each rear window: "IF ALARM SOUNDS, call 911, or call (Your home phone number), or call (your work phone number)." That's what I do. If a car thief or robber wants a reason to pass over your car, this should give him a good reason to look elsewhere.

Burglar Alarm, Mode II: I connect a detector to my indoor light switch, so when a door is opened, a sequence begins: there is a wait of four seconds. Then a LOUD beeper starts. After four more seconds, it starts blowing the horn. This is enough to chase most car thieves away. Schematic not shown, but you could easily figure it out yourself.

Burglar Alarm, Mode III: I built up a timer that is very useful. When I leave the car, I just set it to run. It blinks for a while and then turns itself OFF. I don't know very many people who are stupid enough to break into a car where all sorts of winken-stinken-blinken is going on. In my next column, I'll write about some more circuits.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@webteam.nsc.com—or:

Address:
Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

Bob's Mailbox

Dear Bob:

In your April 20 column, you mentioned that someone corrected your use of the red thermocouple wire as the positive lead. Actually, there is no "correct" answer.

It seems that the IEC standard for thermocouple color coding calls out red as the *plus* lead; this standard is used around the world, except in the U.S. The U.S. uses an ISA/ANSI standard for thermocouples that calls out red for the *minus* lead.

This standard has expired, and there is a big controversy going on (or at least there was a few months ago) over whether or not to adopt the IEC standard in the U.S. (This would cause quite the confusion, what with the huge installed base of *minus* red lead thermocouples already in place.) You can search for more info about this on the web.

DEAN ATHANIS
Another ex-Philbrickian,
via e-mail

P.S. I got five minutes for the bridge crossing puzzle, too—although I bet Ari would've slowed down a bit by the time he carried the third guy across!

Thanks for clarifying "which way is up!" Maybe they'd better pick some new colors—not red or yellow. And hey, that ARI is a tough guy! (One guy suggested they could get over in 12 minutes if they just waited 'til morning.)—RAP

Dear Bob:

Re: manhole covers (Puzzler #7, in the April 6 issue): I knew why they were round. In Minnesota we had rectangular storm drain covers, which *some kids* would often drop into the sewers below. But not having been in Nashua very often (I did live in Lynn, Mass.), I failed to notice the triangular manhole covers up there.

I immediately thought of a large pressure vessel, such as a boiler or locomotive inspection cover. This type of "Manhole" is big enough for some hap-



less boilerworker (boilerperson doesn't sound right) to crawl inside. The cover has a ledge on the inside to withstand the high pressure, and is merely held in place from the outside by a set of "dogs" or other clamping device. The manhole is oval, to permit it from being unbolted. And when the pressure is relieved, it may be lifted into the vessel, twisted 90 degrees twice, and withdrawn from the pressure vessel. Does this count as a non-round "manhole?"

ROBERT DAHLGREN
Fujikura Technology America Corp.
via e-mail

Hello, Robert D. On the FRONT of a steam locomotive, you will often see a large round Disc, the inspection hole for the Steam Box—fastened down by bolts or dogs. Those discs are round, usually. Perhaps three or five feet in diameter. But THEY do not have to hold any particular pressure, maybe three or seven pounds per square inch. They are just fastened on the outside of the engine, on the front.

The manholes YOU refer to DO have to stand off a whole lot of pressure. You are correct that oval is a very good shape for them, and that they get turned and turned and mounted inside.

In some cases, where there is not a lot of stress, a single bolt & (two-eared) clamp holds them in place. I can't guess how many years ago that was figured out, but maybe 200 or 300? Maybe more? I'll try to check into this. Your point is nicely taken.—RAP

Hi Bob:

I always enjoy your Pease Porridge. In regard to the April 20 column, you mentioned getting a "whack" for spilling your milk as a kid. Well, as recent parents, we give our son "swats" for being bad. We don't punish accidents, but deliberate misbehavior is another matter. (*I tend to agree with your policy. Of course, there is every kind of INTERPRETATION....rap*)

We have an excellent example of

what not to follow living across the street. On one occasion, we observed the younger boy taking a roundhouse swing of a hollow plastic bat and connecting (squarely, I might add) with the back of his older sister's head. Repercussions, you might ask? Their mother ordered the boy to apologize to his sister and give her a hug. (*One of these days, he may use a wooden baseball bat, not realizing what damage can thus be caused...not just repercussions, but CONcussions—or death. Sigh. /rap*)

This is but one of a forest of stories about these kids and their parents. By not controlling and punishing this behavior, the parents encourage them to use similar tactics on others (and it has happened).

So, the question to ask the reader who claimed you were "brutal" to your son is: Who is more "brutal?" The parents who allow their children to misbehave, so as to not damage their delicate psyches—yet the children grow up to be reckless and irresponsible adults? Or, the parents who risk hurting their children's feelings when they misbehave so that they grow up to be responsible and respectful adults? (*A very well-phrased question.../rap*) I happen to believe that you did the right thing.

Bob Becker
via e-mail

IF my son had pulled the glass away, I think I would have given him a very SMALL swat—just to get his attention, maybe a rough pat on the shoulder, so he would realize he had made a mistake.

*I know a gal who always threatened her kids, "If you don't start behaving right away, I'm going to beat your a** 'til your nose bleeds." But she never did. And I think one of her kids grew up OK. The other one I'm not so sure about, and the third is in the PEN, doing 5 to 10....*

Sigh...one out of three is not a great batting average....—RAP

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What's All This Circuits-In-Your-Car Stuff, Anyhow? (Part II)

Let's continue with some more of the circuits I am building to put in my newest car:

Burglar alarm, Mode IV: When the ignition is OFF, this circuit drives some brief, low-duty-cycle pulses through a couple of LEDs (*Fig. 3*). You can use any low-power op amp you want. The overall battery drain is probably not enough to drain your battery in a month of disuse. I mount the LEDs near the lower corners of the windshield. These LEDs can also help you find your car in a dark parking lot. They stop blinking when you turn on the key.

Hand brake alarm: I am not going to put this on my new VW Beetle, because I never forget (or fail to notice) that I left my hand brake on. But, if I was setting up a VW Bus, I'd add that alarm. I would build a 400-Hz oscillator,

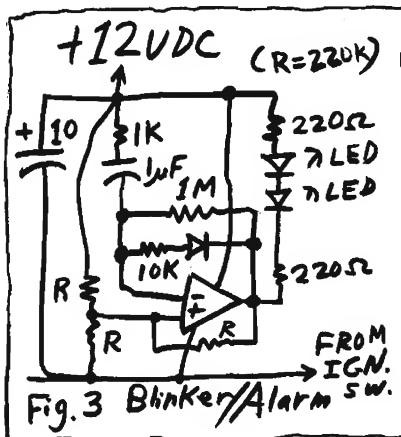


BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

Of course, if you already have a warning light, you might not have to build it. But, if the warning light is not sufficient, an additional beeper might be helpful.

Horn modulator : I received a nice letter from a guy who had read my column on Reflex Response, where I was trying to warn a dog to get out of the high-



speed lane. He explained that if you REALLY want your horn to work well, and get the warning across to a dog or a person—chop it at 4 Hz. I asked, “Won’t it work better at 2 Hz?” He said, “No, 4 Hz.” I will insert a horn chopper, so I can modulate the horn at 4 or 2 Hz. Of course, I will leave the wires set up so I can disable it, and leave the horn in a dc mode. I’ll share this circuit with you in a future column.

Oil-temperature gauge: Am I going to wire up an oil-temperature gauge? Probably. It is pretty easy to tack-solder an LM35H to a piece of copper-clad, and slide that down the dip-stick hole. I did this once, 20 years ago. Not

a big deal. I know my oil temperature gets up to 85° C, in a while. I don't really have to do this, but I guess I will. And, if the LM35 falls off because the solder melts, I'll know the oil temperature got too hot.

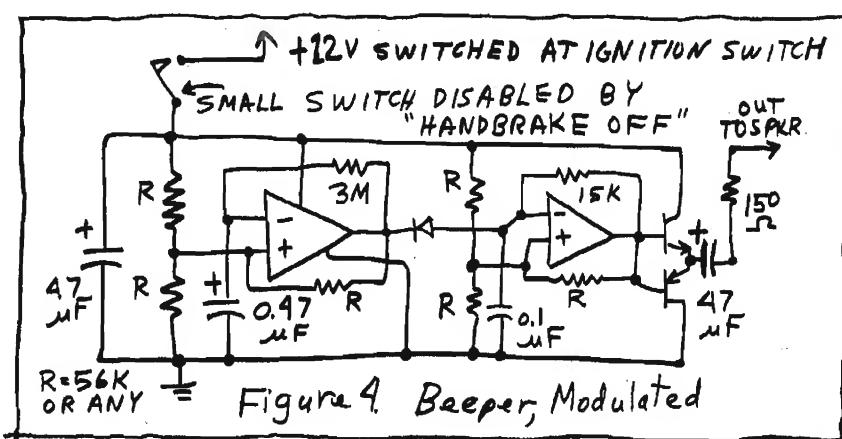
Tachometer: Am I going to put in a tachometer? No. I did that 30 years ago. It used a 2.6-V mercury cell, and every time the engine turned faster, the tachometer indicated that it was happening. When the engine was off, there was no drain from the battery. It ran fine for years, and then I quit running it.

I used to have an old Heathkit CD ignition module. It probably did give slightly longer life on accurate ignition timing. One of these days, I might get around to trouble-shooting it, but it quit working a few years ago, and I've done just fine without it.

Those are all the circuits in my car, until next month. I've been trying to figure out how to get my GPS receiver linked up, because you can't just leave it on, and you can't just turn off the power. But I think I have a solution. Now, as I said at the start of all this, these are kind of *chicken-manure* circuits. And we will all agree these circuits are not very sophisticated. But it is what you *do with them*—how you interface them to the world—that makes them effective.

All for now. / Comments invited!
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Bob's Mailbox

Hi Bob:

I read your column on soakage, and I can add only one thing to the phenomenon of capacitive discharge. Having been involved in electronics as a hobby since I was ten, and having worked repairing test instruments a few years later, I have often found myself in the path of a capacitive discharge. We actually had a policy at Philips that if you got a jolt, you had an EKG. It turns out that electric shocks can cause cardiac arrhythmia, even if you feel O.K.

MIKE McGINN
via e-mail

I presented your valuable idea to our health dept. Thanks, Mike.—RAP

Dear Bob:

In your column of Nov. 17, 1997, Chris Anderson bewailed the lack of instruction in component characteristics in EE programs. I agree wholeheartedly, and therefore, we teach about the differences between aluminum 'lytics, tantalums, and polyester caps, plus carbon-comp vs. metal-film resistors, air-core vs. ferrite-core vs. iron-core coils, etc. in our Electronics Engineering Technology program. Of, course, our graduates are technicians, not engineers—although some of their employers *call* them engineers, and put them to work designing motor-control devices and the like. But we don't claim they're EEs.

A local man had two sons. He sent the elder to a well-respected, state-supported university to major in EE. The younger son came to our school. When the elder was a junior, he visited his brother at our school, where he was shown some of the lab projects (design, build, calibrate, and test an analog multimeter; design and build a frequency counter, etc.) that kid brother had built. His response, "You have LABS? We haven't had a practical lab, yet!" Upon graduation, the two went to work for the family business of selling and maintaining woodworking equipment. The father decided that the younger had a



more-valuable education for hardware and software maintenance of the machinery and the proprietary computer network than the elder.

The moral of this story is that as long as our educational system values credentials above practical experience, and rewards research grant acquisition rather than program quality, we will continue to graduate engineers who don't know a carbon-film resistor from a 100- μ H coil. (Hey, they're both tan cylinders with stripes, aren't they?)

But, how do you get good students into good programs? Parents and counselors steer the best students toward a four-year degree—any degree—rather than an EET or CET two-year degree (which can serve as stepping-stones for a higher degree, by the way). I've bought shirts from guys with an MA in History. The fellow who buys used books here on campus has an MA in Psychology. And manufacturers are *crying* for technicians, starting at salaries from \$25,000 to \$35,000. When we finally realize that a BSEE with 15 years experience is at least the equivalent of a PhD who never worked in industry, and that the status of a degree in Oceanography or Political Science won't pay the grocer, maybe we'll stop exporting our lunch to other countries.

RICHARD HONEYCUTT
Electronics Instructor
Davidson Community College
Lexington, N.C.

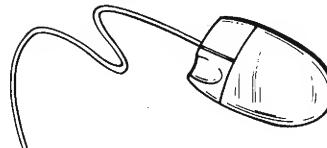
We expect engineering schools to teach theory and analysis—both are important. But should we expect innovation from the brilliant theorist or the bright technician? In the real world, one, the other, both, or neither may be a good inventor.—RAP

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What's All This "Driving Into Accidents" Stuff, Anyhow?

Awhile back, I decided what I would write about for my next book. It took a year longer than I expected, but it's here: *How to Drive Into ACCIDENTS—And How NOT To*. It's 488 action-packed pages. (OK, one page is blank.)

What is the book about? I want beginning drivers to learn thoughtful, advanced techniques for making decisions, driving defensively, and avoiding accidents. So, I wrote about all the ways that funny little habits or quirks become bad habits, and how these can work together with other factors—conspiring to cause accidents.

For example, most people have figured out that the phrase "Speed Kills" is baloney. Yet, driving fast CAN compound with other factors to get you in trouble, cause accidents, and get you

killed, or, even worse, get you badly injured.... Whereas bad visibility is much more perilous than merely speeding.

Why am I qualified to write this book? I have driven over 1,000,000 mi. I have seen other people's accidents, and discussed them. I think that I know enough about cars. And I think I understand the physics, the mechanics—and human nature.

BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT-
OR CORP.,
SANTA CLARA,
CALIF.

Why did I think I could write this book? Hey, I have already written one book, so I knew I could write another. Word by word, paragraph by paragraph, topic by topic, file by file—I knew I could do it.

Process those words. CRUNCH those topics. I was confident that by September, I'd have 90% of the draft typed up. Yeah, but back in 1995, I neglected to say, September of *which year*.

Who is the book for? It's for any inexperienced or new driver. Now, a person who doesn't know much about driving yet, or doesn't drive, is not going to appreciate all this stuff, until later. That's OK. This is a good book for beginning and intermediate drivers. I do not think it will screw up the head of the non-driver, but it won't do him a lot of good, either. I mean, if you have never held a tennis racquet in your hand, a book about how to play better tennis is not going to sink in really well. (This book is NOT intended to teach you to drive. You need a smart driver, a good teacher, for that. Then, this book can be helpful to teach you to be a *better* driver.)

Who is going to buy this book? Obviously, that is where the mothers and fathers of the young drivers come in. They are going to buy a LARGE number of the books. That part is easy. Obviously, I can sprinkle around just enough guilt-oriented comments that people will buy. What parent would not buy this book, for his kid? Then, after the kid starts to read the book, I have to keep his interest—with good writing, interesting ideas; and, most of all, examples. Examples of accidents and near-accidents.

Obviously, this book has to get good reviews, well-targeted advertising, etc. I have a lot of good ideas about how to promote this book.

What's in the book? There's about 61 chapters, about 380 pages of important topics. Additionally there's about 100 pages of appendices that give you good advice on driving competently. There are four of my columns reprinted from *ELECTRONIC*

DESIGN—on Reflex Response, Dead Cars, Stupid Dangerous Stuff, and Double-Clutching.

Where's the incentive for me to write this? Lots of \$\$\$? Well, I am going to give one-third of the profits to safer-driving organizations, and one-third to safer-flying organizations. The other one-third (after taxes) will probably not be enough for me to retire on. But that's ok. My motivation is to save lives and save pain. Maybe in the long run, our automobile insurance rates will stop rising!

What was the first motivation for the book? My cousin lost her daughter, Christine, in an unfortunate car accident, a few years back. The idea began to grow, but I got sidetracked until the fall of 1994.

What's the big deal about safe flying? I lost three friends who flew into the ground. Chuck Everhart used to work for National, 20 years ago. He was a test engineer in National's ALIC group—he programmed our first Teradynes. He was an excellent, safe, conservative, and cautious pilot with over 5000 hours of flying time. All of his friends were confident that Chuck would be a long-term survivor, and would retire from flying at the age of 85. He was flying up in the foothills, up near Tuolumne City, Calif., in December of 1994. He was too low for a ridge, in heavy clouds; he barely cleared the ridge, but clipped a tree. Killed instantly. Too darned bad.

Ron Brown was taking a student on a lesson. A plane sneaked up behind him and did not see him. It clipped off his tail, and he lost control. They crashed and died.

Kathy Raphael was flying with her instructor and one other student, a couple years ago. They were all three good, smart pilots. They flew up a canyon in the Sierras, near Sonora Pass, Calif. The canyon got too tight, and they could not climb out of it, nor turn. They tried to loop out of it, crashed, and were killed instantly. They all knew enough to not try to fly up a canyon. But somehow, inadvertently, they did fly up the canyon. Paid a terrible price. Sigh. That motivated me.

I wish I could write a book to save the lives of young pilots, but I am not wise enough to do that. I'll let somebody else do that. But I CAN write a book to help young drivers. So I did. It just took

all my spare time for a couple years.

The format of the book is explanations about how to drive correctly, and interesting stories about accidents, indicating how the various factors conspired to cause the accident.

How did this accident "happen?" What were the drivers THINKING? If you were in the same situation, could you avoid the accident by thinking? Or would you be better off if you were just trained to *react*? This book is as much about thinking, as it is about driving. I certainly am not going to teach kids anything by being preachy, but I think I can teach them with examples.

All along, I said that I wanted the list price to be not much more than 12 or 14 gallons of gas. Paperback. Affordable. (But if the price of gas goes down or up, I am not going to change the price of my book.)

I pitched this book to several publishers. I got a nice rejection letter from each one. That's OK. I just decided to self-publish. I'll show all those guys they were wrong! (Revenge is a GREAT motivator!)

Is there a possibility of a sequel, a video, a CD-ROM? Quite possible, if I get suggestions from readers. But I want to get this book out promptly, and start saving lives.

Ah yes, and what is the theme of the book? That quote from Count Otto von Bismarck, that was on the back cover of my older book: "Fools you are ... who say you like to learn from your mistakes.... I prefer to learn from the mistakes of others, and avoid the cost of my own."

For more information on this book, send a note to the address below, or you can also check out my new web site and obtain complete information: www.transtronix.com. To order this book, now in stock, send a check for \$21.95 (tax and shipping included) to: Robert A. Pease, Pease Publishing, 682-E Miramar Ave., San Francisco, CA 94112-1232.

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Bob's Mailbox

Hiya Bob:

In case 450,000 people haven't suggested this already, here goes: Our new car (which, alas, is new) keeps the radio playing until you open a door. I like that! (*But what if I want to listen with the door open? I don't like that.* /rap) A timer isn't a bad idea, but what if you need 10 more seconds to hear whatever it was you wanted to hear? (*I just turn on the ignition for another 2 seconds, and the timer runs again. I don't have to wait for it to shut off. I just turn the key momentarily.* /rap)

I assume you have a door-activated dome light, as you mention using a door switch for some items. You could build that for your car, too.

BURCH SEYMOUR

via e-mail

Yeah, but I don't WANT a setup like yours. When I get out of my car, I want the radio to keep playing until I get in the house. With your setup, I would have to climb out the window. No, thanks!—RAP

Hi Bob:

Several years ago, I came across a neat little circuit that would flash my motorcycle's main headlamp alternately between low and high four times a second. I thought this little attention getter might give me a tad more visibility. It certainly did. A police officer informed me that only emergency vehicles could have this sort of display. Until your laser hologram becomes available, I'll just treat everyone as though I'm invisible and give 'em (and me) lots of room.

DARAL R. MAKAHUSZ

via e-mail

I've seen motorcycles with their headlights blinking away wildly like this. At least in the daytime it ought to be OK. I can't imagine anybody complaining. Check your state traffic laws—the cop might be wrong.—RAP

Dear Mr. Pease

I always enjoy your column, and was amused about the round manhole cov-



ers. Here in England, most of them are square or rectangular, and we don't seem to drop them into the manholes!

On another topic: Breadboarding. I use strip board with strips and holes at 0.1-in. spacing. I've found it easier to use it upside down, i.e. soldering the devices into the strip side. At HF, I "super glue" copper foil onto the other side to form a ground plane. It may not be very good above 50 MHz, but it's OK up to there using phenolic-based strip board. I haven't anything so crude as figures to back that up, but things seem to work.

Sorry to hear about your VW Beetle. I've never had one, but they are a cult car here, too. (I'm not a professional, but a Ham Radio man.)

DICK BIDDULPH

via e-mail

Yeah, there are lots of breadboarding styles. So long as the ground plane is nearby, they work well. My newest (1970) Beetle sure runs strong. And—HA!—it has 10% more trunk space than the New Beetles.—RAP

Dear Bob:

I get so many trade publications I can't possibly ever read them all. Well, anyway, just a note to tell you that no matter how many Tech. Pubs. I get, I ALWAYS seek out your articles for a breath of fresh air. When work is unusually hectic, I can always read one of your columns and bring immediate sense to my day....

MICHAEL WRIGHT

via e-mail

Thanks, Mike. Yes, I even go back and read my own stuff, to find out what I wrote! Sometimes it makes a good break from THINKING!—RAP

All for now. / Comments invited!

RAP / Robert A. Pease / Engineer
rap@web.team.nsc.com—or:

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

Bob's Mailbox

I know you're probably expecting a column this issue, but I switched things around due to unforeseen stuff. /rap

Hello Bob:

Just thought I would add my two-penny worth to the child punishment debate. Whilst bringing up our three children (the eldest is now 8), my wife and I have always considered that a swift but scaled punishment (i.e., a smack) is always preferable to a deferred punishment (i.e., no biscuits for a week). (*I would never say that is NEVER an appropriate punishment. It might be appropriate for some pre-meditated crime. /rap*)

In my experience, a young child loses focus of what the punishment is for after a few minutes. I think it is very important, however you punish your children, to allow the child to relate the punishment to the crime. (*I tend to agree. /rap*)

If the child does not understand what is wrong, punishment will only cause confusion. (*Even for DOGS, people have learned this! /rap*) We have both found that the threat of punishment has diminished its occurrence. We now smack our children very rarely; it just isn't necessary. (*Ah—they have learned. I think your teaching is working pretty well. At our house, we were able to get on the same learning curve. /rap*) I think the real problem here is that the "thought police" are out and about in force. (*Check. I have not run into them, but I have ducked that for years. The "politically correct" movers are swarming in some such areas. /rap*)

I know many people who don't smack their kids who have brought up fine children. I equally know families who have struggled. I think that what works is best. And, within reasonable bounds, people should be left to bring kids up without the worry that the local social services will remove them. After all, bringing up children is probably the most difficult job going. (*Check. /rap*) There are very few role models. Most of us only get two to



view close up. (*But there are others we can learn from, while we watch from some distance. /rap*)

Keep up the good work. I am strictly a 0's and 1's man, but I always read your articles. Some of it loses me, some of it sinks in. I hope you're never too old to learn.

ALUN HUNT

via e-mail

Well, Alun, some people have learned the concept of NEVER hitting a child. Others of us have not agreed on that. I don't think either side is wrong, and neither side has an easy task. My main tack would apply when a small child tries to reach for a hot item, such as a stove or soldering iron. I would reach out my big PAW and SWAT her hand away from the hot object to interdict the harm. Then, I would immediately try to EXPLAIN why the hot item would be very painful. Every kid has to learn how to recognize hot objects. I have been fairly successful at explaining to my kids why they should not do something. I want them to learn to trust me when I say, "STOP!—DON'T do that, and I'll give you five reasons not to." Then I would have to

explain five good reasons why they should not march out into traffic (because a car is coming) or some more obscure danger. We adults are not perfect, but we have to teach our kids to trust us when we warn them, "NO!!" Fair enough? But, as a matter of semantics—or of degree—I have always been willing to give my child a calibrated SWAT, but not a SMACK. We certainly agree that we should not beat kids—or wives—or anybody else.—RAP

Dear Bob:

I always enjoy reading your column. Regarding Bob Becker's letter and your comments (*ELECTRONIC DESIGN*, July 20, p. 113), I would like to draw your attention to a simple truth found in the 24th verse of the 13th chapter of the book of Proverbs:

"He that spareth his rod hateth his

son: but he that loveth him chasteneth him betimes."

For those who would question the ultimate author of these words, consider, at least, the reputation of their human author concerning wisdom. Regarding conventional "wisdom," note the 22nd verse of the first chapter of the book of Romans:

"Professing themselves to be wise, they become fools."

The full chapter provides the proper context for this statement.

JEFF MUMMA P.E.

via e-mail

Jeff, we tend to agree that sometimes children need an education. As I said at the end of the previous letter, maybe a swat betimes. But, I don't ever recall taking a rod or switch to my kids. Just a swat.—RAP

Dear Bob:

I'm not sure what you mean by "linking up your GPS receiver," or even why you'd want to. But, a friend of mine showed me his GPS, playing through a laptop that was running a portion of the "Precision Mapping" program. The result was very nice—a large, moving map display of the area being intercepted by the GPS receiver. As we drove, you could shift your eyes from the laptop screen to the street signs as they went past—in total agreement!

BOB SWINNEY

via e-mail

Hello, Bob. I am not trying to get perfect linkage of my ACTUAL position and my GPS position to read out. I just want to be able to turn the GPS off when I turn the key off—without sucking down the battery. Yes, YOU, the passenger, could see the laptop display and the street signs. But, was there a way the DRIVER could do this, without getting into accidents?—RAP

Dear Bob:

As I read your article on touch typing, I gave pause to reflect on why I took typing in high school some 33-odd years ago. And, I remembered that I was one of two males in a class of 24 females. I never got much above 30 wpm. The funny thing is I can't remember any of the girls, but I never forgot how to touch type.

DAN VANDAME

via e-mail

I'm typing up around 30 wpm, and I can't gripe. I learned at home from my mother and a couple of simple books. I never forgot the girls in school, though!—RAP

Dear Bob:

After reading your "What's All This Circuits-In-Your-Car Stuff" column in the Aug. 3 issue, I was reminded of the time that I "improved" upon the "blinker audibility" in my 1984 Cadillac Cimarron. It was very hard to hear the blinker's thermally activated contact reed. So, I decided to use a salvaged Mallory Sonalert sounder, fed by a couple of isolation diodes (one for the right, one for the left blinker circuit). This would better alert the driver when the turn-signal blinker was "on."

It worked fine, and the audibility was great from the driver's perspective. What I hadn't thought of, however, was how it would affect my wife when she was riding along with me as a passenger! Women, in general, seem to be more sensitive to high-frequency sounds than men. And, as just a passenger, the Sonalert's frequency drove her crazy (even at a deliberately reduced volume level).

So, the bottom line would perhaps be: Before finalizing any sort of audible alert in your car, it might be prudent to fly it past "she who must be obeyed" first. Try to pick a sound that won't be terribly annoying to others in the car who are "captive" to our creative genius!

DAVE MILLER
via e-mail

Maybe an adjustment pot in series with that Sonalert will let you control its volume. Or, tape some foam over it! And, beam it toward the DRIVER!! They are fairly directional, right?—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@web team.nsc.com—or:

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Santa Clara, CA 95052-8090

Note: RAP will be trekking in Nepal all of October. Don't expect much response to your mail or e-mail until November 10.



Is your Fibre Channel cabling haunted by the Skew demon?

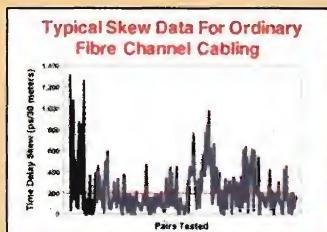
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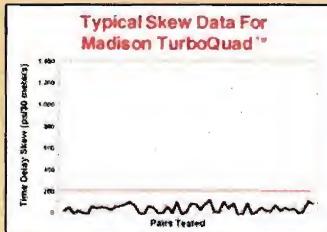
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What's All This Circuits-In-Your-Car Stuff, Anyhow? (Part III)

As I was saying before we ran out of time and space, there are still a few more circuits I'm adding to my car (*ELECTRONIC DESIGN*, July 6, p. 113 and August 3, p. 99).

Directional-light flasher: I was going to build a new directional-light flasher circuit, for my OLD 1968 Beetle, because the old flasher circuit had worn out and gotten flaky. But since I was replacing the whole car, I naturally figured that I wouldn't have to build that circuit.

Oops! I noticed on my new (1970) VW, that when I hit the directional signals, the indicator light on the dashboard would turn on instantly. But the actual blinker signals on the outside of the car would not turn on for 1 second—in the second half of the cycle.

WELL, I didn't like that one bit. I may have been driving around for a lot of miles in cars that did that, but I don't have to put up with it.

I like to hit my blinkers early, so other drivers can tell where I want to go—for example, to change lanes. But I don't like the idea that when I hit the switch, nobody sees my blinkers until after a 1-second delay. Do YOU KNOW if your blinkers actually start blinking so that OTHER

DRIVERS can see them right away? I have gone on record saying that I hate cars whose windshield wipers do not begin to move until 0.4 seconds after you turn them on. I hate that delay.

The circuit diagram shown in Figure 1 will start flashing the actual directional lights, right away. No relays, no contacts to wear out.

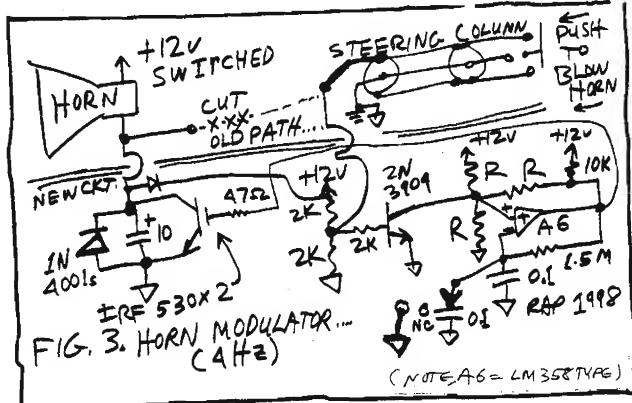
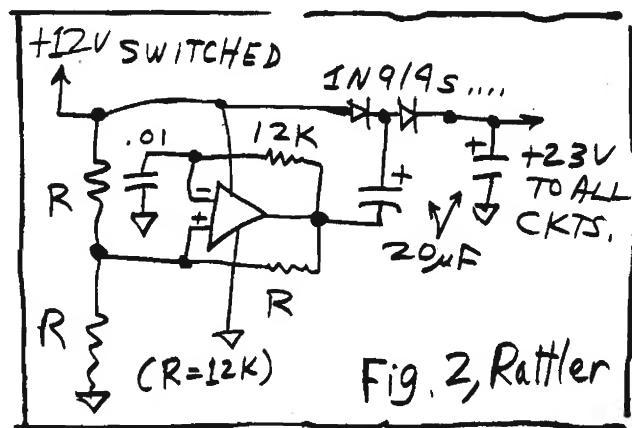
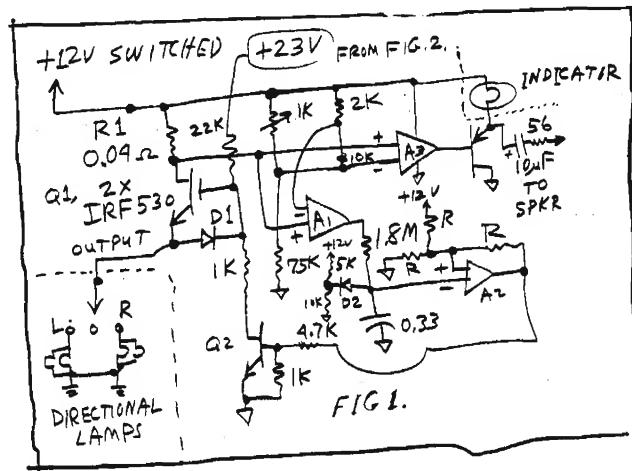
The diode D2 is a little catch circuit, so the first BLINK is not longer than normal. (I hate when the first blink is very slow like that.) Q1 is normally turned ON while waiting for a load to be connected. As soon as a load current flows through R1 (which is 4 ft of 20-ga. wire), A1 starts to pull the 1- μ F capacitor down.

Then A1 and A2 form a conventional triangle-wave oscillator. A3 drives the LED indicator and makes a tick sound in your radio speaker—but only if BOTH bulbs are working. If one bulb goes out, the LED indicator will not light. (Trim that pot.) A1 and A3 should be a FET type, such as an LF411 or 1/2 LF412, so its common-mode voltage includes the + rail.

This circuit uses

a milliampere or so from a +23-V supply, which is generated by the little rattle in Figure 2. You can use almost ANY op amp here. You could use a CMOS gate, and get slightly larger output, but I would not trust CMOS circuits to run on +14 V, in case of transients. It's easy and safe to get adequate output from an op amp (23 V from 14-V in) that would survive 36 V.

Horn modulator: What is a horn modu-



What's All This Circuits-In-Your-Car Stuff, Anyhow? (Part III)

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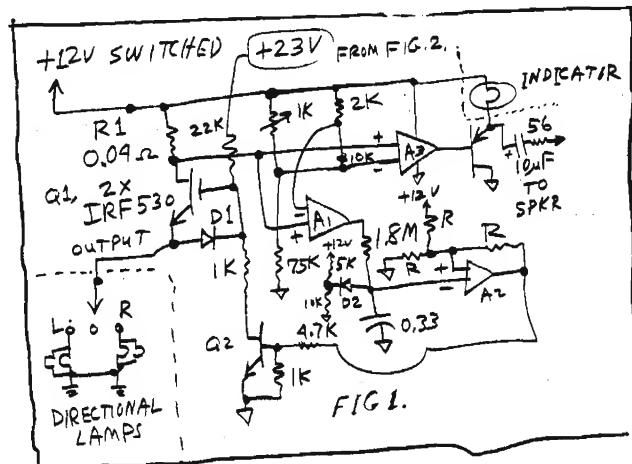
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Horn modulator: What is a horn modu-



PEASE PORRIDGE

BOB PEASE

Horn modulator: What is a horn modulator? I got a nice letter from a guy who had read my column on Reflex Response, where I tried to warn a dog to get out of the high-speed lane (Electronic Design, Dec. 5, 1991, p. 125). He explained that if you really want your horn to work well, and get the warning across to a dog (or a person), CHOP IT at 4 Hz. I asked, "Won't it work better at 2 Hz?" He said, "No, 4 Hz." So, I built this horn chopper that will allow me to chop the horn at 4 or 2 Hz (Fig. 3).

Of course, I will make it easy to turn this off, and keep a "dc" horn path. In this circuit, I did not put in a catch diode, so the first BEEP is longer than the rest. It seems to work. I like it.

Have you ever watched the strobe lights on an airplane at night, and wondered if there wasn't a better way to track it? The first time I saw this was 24 years ago, and I was impressed: the strobe light would blink twice, with a spacing of about 0.3 seconds, and then repeat after about 2 seconds. I immediately realized, even in the first 4 seconds I ever saw this, that these blink pairs were EASIER to track than the ordinary, dumb, evenly spaced blink, blink, blink. I really like that scheme for the strobe lights on planes. But, I don't think I will build this into my horn....

Back in July, I observed that you might want to turn your radio on and off with a FET switch instead of the crude pnp Darlington I showed there. That would be easy to do by connecting up another transistor, similar to the ones shown in Figure 1, to turn the radio on and off. The FET's ON resistance can be as low as you'd like—using a tiny bit of current from the +23-V supply.

Did you hear that Sidney Darlington passed away recently? In his obituaries, they listed a lot of things he invented besides just the compound transistor connection that everybody knows. My old colleague from Philbrick-Nexus, Al Pearlman, still claims that he invented the "Darlington" first, but Darlington published first.

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@webteam.nsc.com—or:

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Bob's Mailbox

Dear Mr. Pease:

Re: "What's All This Stuff, Anyhow? Volume Three," that accompanied the Aug. 3, 1998 issue of *ELECTRONIC DESIGN*:

Laboring under a stereotype of my youth until I read your memories of Bob Widlar, I thought of you as nearer my own age. I apologize! In my younger days, the old codgers wore the beards. Now that I'm past 80, it's the young bucks who wear them!

Seriously, though, I can empathize with your typing trials and tribulations. Since my mother was only a farm girl and a housewife, she couldn't teach me how to type. I did take a year of typing in high school (which I barely passed) because my penmanship was atrocious. And, I wanted to be able to submit legible papers in college.

It did teach me the fundamentals of touch typing. However, I suffered from the same problem as you. It wasn't until I got my Commodore 64, with a word processor known as Speed-Script, that I became a real touch typist. Being able to correct errors easily, without resorting to an eraser, Erasable Bond, correction tape, or Liquid Paper, gave me the confidence I needed to become good at it. (I still cheat occasionally, though!) Now I use a homebrewed 486DX40, running WordPerfect 6.0 under DOS. (I refuse to bow to Gates, unless a total meltdown forces me.)

About carpal tunnel syndrome: We never heard of it among the thousands of women (secretaries and stenographers) who—before Selectrics, computers, and word processors—spent their days banging away on manual typewriters. All—or most of them—were touch typists. The only time I experienced it was in 1980 when I had to spend hours on a Model 33 Teletype, punching paper tapes to program a minicomputer. If you ever experienced one of those atrocities, you'll know that you had to literally HAMMER the keys to accomplish anything. The only way to do that was by



WRIST motion—fingers were too weak.

I doubt if many, or any, of those who suffer from carpal tunnel syndrome as a result of operating computer keyboards are touch typists. I'd venture that most of them use the "two-finger punch" method, with lots of lateral

wrist motion. If they won't learn to touch type, they could avoid a lot of pain and suffering by changing to a stiff-wrist, forearm motion.

ROBERT J. NEDRESKI

via e-mail

Yeah, I'm just a kid of 58. (When I graduated from MIT, I was barely 21.) The earlier you start learning touch-typing—or any other strange "language"—the better. My mother was a farm girl—and a housewife—and a MOTHER—and a TEACHER. Ain't every mother a teacher? Hope so!—RAP

Dear Bob:

Thanks for the "What's All This Widlar Stuff, Anyhow?" in the Aug. 3, 1998, "What's All This Stuff, Anyhow? Volume Three." I have always enjoyed Bob Widlar anecdotes. I used the early LM709 op amps and most of the other Widlar creations. Wasn't the LM108 Widlar inspired? If he were alive today, we might be working with monolithic 26-bit digital-to-analog converters, etc. What a genius!

BILL BILLINGSLEY

via e-mail

Yeah, Widlar invented the LM108 about 30 years ago. But if he were still around, we would have 31-bit op-amps. However, we now DO have 30-bit (resolution) op-amps such as the LMC2001. Twenty-six bits is not a big deal.—RAP

All for now. / Comments invited!
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What's All This Recipe Engineering Stuff, Anyhow?

TAKE one pound of red kidney beans. Sort them carefully and reserve any pebbles and stones. (After you have saved a pound of stones, you can take them to the store for a refund.) Put the beans in 6 cups of water, in a large (5 or 6 quart) pot. Bring the pot to a boil, and boil for two minutes. Turn off the heat, cover, and allow to soak for two hours. Pour yourself a beer and take a break; you deserve it. Plan to chop veggies....

When I was a kid, I could not tolerate the mealy taste of beans. But eventually I learned to appreciate them, and now I am making up for lost time. Thus, whenever my wife goes away on a trip, I make up a big pot of chili con carne. It's not that she never makes chili, and it's not a gas problem. I just like this recipe.



BOB PEASE
OBTAINED A
BSEE FROM MIT
IN 1961 AND IS
STAFF
SCIENTIST AT
NATIONAL
SEMICONDUCT
-OR CORP.,
SANTA CLARA,
CALIF.

— and that was 30 years ago.)

The original chili recipe had 2 lbs. of lean chopped beef, plus 1/3 cup of suet for frying the vegetables. It only takes one try at finding suet—when there is

none at the Safeway or four other markets—to begin to realize that if you start with ordinary hamburger, fry it, and save the fat, it's substantially equivalent to the fat from suet. Plus, it's much cheaper—and more available. Similarly, the original recipe called for 3 teaspoons of salt and 3 teaspoons of chili powder. I amended that to 1/4 teaspoon of salt and 12 teaspoons of chili powder.

What's a mere factor of three or four or twelve?? I have made this recipe over twenty times. (My wife does a lot of travelling.) I usually make 1.5 recipes, and it makes a great breakfast for 10 mornings in a row. Here's the complete recipe:

RAP's ChiliconCarneconFrijoles (with Beans):

1 lb. red kidney beans, sorted
6 cups water
2 lbs. coarsely chopped beef or
hamburger, *not* very lean
2 onions
2 green peppers
3 garlic cloves, minced
28 oz. canned tomatoes or fresh
tomatoes, chopped coarsely
1/4 teaspoon salt
6 to 12 to 18 teaspoons chili powder
1 teaspoon paprika
1/4 teaspoon tagarashi (Japanese HOT
chili powder) (*optional*)
1/4 to 1/2 teaspoon red pepper flakes

Set the sorted beans to boil in the 6 cups of water for two minutes. Then turn off the heat, and cover and soak for two hours. Meanwhile, chop the onions and green peppers into fairly small pieces (1/5 by 1/3 in., or as you prefer). Chop or crush the garlic. Chop the tomatoes.

Fry the beef 1 lb. at a time over high heat in a large skillet, browning it well in some places. (It will be well-cooked later, so you do not have to cook it uni-

formly.) Set the beef aside in a bowl, draining the fat back into the skillet. There should be 3 or 4 tablespoons of this fat in the pan. Or, add a little shortening to bring it up to at least 2 tablespoons.

Fry the onions, green pepper, and garlic over high heat so some of it is browned and most of the onions are at least translucent.

IMPORTANT: Now, drain off most of the fat from the onions. You might put back a little fat later. But, as the fat takes in the spices, you have to do it now or lose the spices when you take off the fat later.

Then, add the tomatoes. When it gets back to bubbling, turn down the heat to simmer. Add the basic spices: salt, paprika, pepper flakes, and about 6 teaspoons of chili powder.

NOTE: As there are such great variations in the strength and heat of purchased chili powder—and such differences in each person's taste and enjoyment of hot food—you must start with a little chili powder. Add more, to taste, later.

Stir and mix. Add beef. Stir and mix. Allow to simmer at least an hour.

After the beans have soaked two hours, apply heat and bring to a boil. Simmer covered for an hour or two until the beans are more or less cooked, *al dente*. (Some people change the water, but this recipe doesn't seem to need that.) Add water as needed to keep beans covered.

NOW add the meat and spices and veggies to the pot of beans. Bring to a boil. Simmer at least 20 minutes.

Stir the chili and sample. Start to correct the seasonings, adding a little more salt, chili powder, pepper flakes, etc., per your taste. This is a good time to bring in 4 or 8 or 10 more teaspoons of chili powder. But, take it easy on the pepper flakes; they can always be added later. After the flavors have melded for 30 minutes, you will probably be hungry and eat some. But, if you let it simmer another hour or two, it gets better. It gets even better when you re-heat it the second day.

Serving options: Serve with grated cheese on top. Serve over rice. Serve with tortillas. Use green beans or broccoli on the side—or on top. Try a dab of sour cream. It's great with a fried egg for breakfast. That's what I am eating right now as I type. And it goes good

PEASE PORRIDGE

BOB PEASE

with red wine, too.

Variations:

1. Take a pint of the chili and add a tablespoon of water. Blend for several seconds in the blender. Return it to the pot to make a richer, thicker sauce.

2. Take 2 cups of the chili, hot, and add 1 square (1 oz.) of UNSWEETENED chocolate. Heat gradually until the chocolate is melted. Stir in completely. You have an excellent *molé*.

3. Add veggies: carrots and more tomatoes. Add corn.

4. Fool around with the spices. Try more of this and less of that. I often sprinkle a little of the hot pepper flakes on top of my bowl so the main batch is not so HOT, but my bowl can be as hot as I want.

5. Try some different kinds of meat, such as ground lamb, turkey, or whatever is marked down this week. (But turkey is so lean, you'll have to add shortening or butter to fry the veggies.)

When you are finished with the chili for the first day, cool off the pot for an hour in a sink full of cold water so it will not overload the refrigerator. I usually heat up one bowl at a time in a microwave oven. But, you can re-heat the whole pot, stirring almost continuously.

Cooking and recipe engineering can be fun, challenging, and tasty. And, if you avoid making a stupid move, you can avoid a huge pot of inedible "food."

Does the engineering of a recipe take good planning, good *processing*, good *JUDGEMENT*—and good skills at interfacing with *people*? Yeah, for sure. That's why my wife is a much better cook than I am, in general. (But, I can honestly say that I am, at least, an adequate cook on many dishes....)

All for now. / Comments invited!
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Bob's Mailbox

Dear Bob:

Your comments on waking up with a song in your head in your "Obsessions" column (*ELECTRONIC DESIGN*, June 8, p. 179) reminded me of another aspect of music in your head. Sometimes when I'm tinkering at home at my workbench, and I'm stuck trying to figure out a problem or a new piece of circuitry, I'll slide away from the bench and grab my guitar. I'll stumble through a few songs I know, or string together a few amusing cord changes, and then return to the bench. Often, I find this psychic dusting 'n cleaning gives me a new perspective and I can get to the solution I sought.

I believe the playing of music uses the other side of the brain than that used for the intellectual pursuits of electronic design. Maybe the making of music does for me some of what chanting one's mantra or doing yoga does for others. Too bad I can't bring a guitar to work.

BRAD ALBING
via e-mail

Okay, I'm going to go out and buy a guitar.—RAP

Hi, Bob:

Thank you for your clarity and levelheadedness regarding the speaker cable issue! The degree of deliberate disinformation on this topic, and the success with which it masks the established scientific facts, are truly frightening. I never would have thought it possible to deceive so many people so much of the time. The only scam that compares to this is the old "patent medicine" scam that was run on our grandparents. The universal claim was that, "MY product will cure anything that ails you." That scam ended when the U.S. Government stepped in and formed the Food and Drug Administration.

This High-End Audio Hysteria must settle down, or this industry will surely either self destruct or be brought under control. As things stand, the high-end audio industry is



just begging for government intervention to stop the deceptive sales practices that go on every day in high-end audio salons. I can think of no other industry where such routine blatant technological deception is an everyday occurrence. It's time to put the scamsters on notice: Let the

LIARS beware!

JOHN L. MURPHY
Physicist/Audio Engineer
True Audio
www.trueaudio.com

John, I would hate to think that anybody would ever catch me agreeing with a Republican. But, I don't want our STATE or FEDERAL government sending out more edicts on what people can or cannot do. If people catch on to the hoaxes of "ultra high-end audio" and learn to think for themselves, fine. If they figure out that nobody can hear the difference between super cables and inexpensive wire, fine. I have no objection to advice for consumers. But, forbidding such claims is not the American way. Laughing at them is!—RAP

All for now. / Comments invited!
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Note: Back in the "Obsessions" column, I said I planned to pick up a heavy porter's load and stand up, using ONLY a tump line. I made up a load of 90.2 lbs. in two duffel bags and tied them all up. I stood up, unassisted, and carried it a couple hundred yards. I did it again at 88 lbs. So, it's not THAT hard. It's just a matter of know-how. By the time you read this, I'll already have tried this last month in Nepal: trekking to the base camp for Kangchenjunga at Pangpema, at 16,500 ft. I'll let you know how I made out. /rap

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TECHNOLOGY·APPLICATIONS·PRODUCTS·SOLUTIONS

What's All This Manic Stuff, Anyhow?

Awhile back, I was invited to give a lunchtime lecture at the Bipolar Circuits and Technology Meeting (BCTM) in Minneapolis. I talked about "What's All this Bipolar Stuff, Anyhow?" and that also turned into a column (*ELECTRONIC DESIGN*, Aug. 7, 1995, p. 95).

At this lecture, I told a story about a journal my wife was reading. Nancy said, "Bob—this article in this magazine says that people with Bipolar Disorder have a lot of problems, conflicts, fights, suicides, and murders... is that what this conference is about?" I roared, "Yeah, those are all my friends!" When I told this story at the lunchtime lecture, all the audience roared and laughed. And I did, too.

At the time it was amusing because I was not really very familiar with

"Bipolar Disorder." But, I have gotten a little more education. First of all, bipolar transistors and bipolar disorder have NOTHING in common. Bipolar transistors mean ordinary

NPN and PNP transistors, as distinguished from JFETs and MOSFETs. A bipolar transistor has holes and electrons, an emitter and base, and a collector. If you (as I do) still work with bipolar transistors

and want informa-

tion on this conference, contact Jan Jopke at jjopke@aol.com.

"Bipolar Disorder" simply means a person who is alternately depressed, seriously unhappy, and then very posi-

tive and cheerful. "Bipolar" just means alternating from depression to happiness. This definition is not widely appreciated. Even the article my wife was reading was kind of vague about it.

Then a couple months ago, I was absentmindedly listening to the radio at 3 a.m. The guy was talking about people who have this manic phase, are very enthusiastic, and get along on three hours of sleep. I perked up my ears and said, "HECK! They are talking about me!" I listened some more and realized that when a person who has bipolar disorder is in the POSITIVE phase, he (she) is very enthusiastic and positive and gets along great on very little sleep. Conversely, when a person is in the negative phase, they need lots of sleep and are quite unhappy and depressed. I read some more about this in a book by Colette Dowling (*You Mean I Don't Have to Feel This Way?*, Scribner, New York, N.Y., 1991). Well, I have almost always been a positive and happy person. I don't think I have ever been depressed, even in the case of the loss of a great person or friend. Almost nobody gets out of here alive, but most of us survivors will find ways to keep on going and make the world a better place.

When I was a kid, I learned that the St. Germain family up the road came from Maine. Lucien, Bobby, Patsy, and Janora—nice kids. We kids sometimes called them "Mainiacs." It was just a part of learning how to use words—or to CONJURE with words—and I don't think we caused them any pain. It was all in good fun. To this day, I would never fail to call a person from Maine a "Mainiac" if it would make us all smile.

But, what is a "Mainiac?" Is that you—or is it me? Maybe so. You guys may have noticed that I am sometimes DRIVEN with a passion—a mania. Are all manias bad? I dunno. Maybe if taken to excess.

Mark Twain really did say this, probably: "Too much of anything is an excess, bad; but too much whiskey is just right." As usual, he got some parts of the story wrong, but he got some parts right.

What is an excessive enthusiasm? Good for some, not for others. I cannot give all the facts on this, but all you readers will recognize that I've been CRUSADING for several ideas for years, and my energies can be pretty extreme. Many charities that do good for people are similarly endowed with people who are "off on a rant." Good for them. The world needs people who give a damn and are driven and obsessed.

By the way, I sometimes used to read *Machine Design* magazine. But, then it was taking too much of my time. I found a cache of a dozen unread *Machine Design* magazines from '92. I realized there was NO WAY I could read them all, so I recycled them even before my wife began to gripe. But more recently, I acquired a subscription and began reading the recent columns (editorials) of Ron Kohl. He is almost as fine a madman as I am. While he is constrained to a mere 3 kbytes of column every issue, he does really well. I LOVE most of his editorials. I hate to say it, but his magazine and editorials have some EXCELLENT ideas. To sign up, e-mail to circulation@penton.com, or go to their web site at www.penton.com/md/subscribe/index.html. To buy a book of a collection of Ron's editorials (about \$16), called *Mad as Hell*, just dial (800) 213-9150.

On a good day, manics contribute a lot to the world. I try to. I have boundless energy (except when my wife wants me to clean out something).

Is there a CURE for bipolar disorder? Apparently, some of the lithium-based drugs can help relieve the extreme manic state and decrease the depression. It's standard treatment, prescribed by your doctor. I have never heard ANYBODY propose that there is (or should be) a cure for the mania or enthusiasm. What do you think?

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
rap@webteam.nsc.com—or:

Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

Bob's Mailbox

Dear Mr. Pease:

In the Aug. 3 issue of *Electronic Design*, you mention the Heathkit C.D. ignition system. I believe it was the same as the Delta unit that I have been using for many years. I have one installed in my '69 Bronco, and another in my '71 Ford F-250. Both were installed sometime around 1972, and have been functioning with no failures. I recently came across a box full of the same at an auction—some working and some not—cheap. My experience with these is that the usual failure is the SCR, and second the inverter transistors. The whole system is fairly simple. The inverter supplies the high voltage to charge a capacitor. There's a trigger circuit, and that's about it.

Now, on another subject, Home Circuits: I have a front and rear entrance. The front has a motion detector, but I normally park in front and use the rear entrance. Being in a rural area, it gets black out here. I didn't want a motion detector in the rear, as I didn't want it on at times.

What I did was wire a relay to "Blip the motion detector," which would cycle it. The motion detector lights also turn on the side and rear lights at the same time. So, I have three minutes to park, unload, and walk to the rear—under lights. The reverse is the neat part.

I rewired the rear doorbell with an SPDT switch. I charge a large (2000 μ F) capacitor through a resistor. The switch grounds the doorbell and Blips the motion detector relay by discharging the capacitor through the relay to the ground. The resistor controls the rate the capacitor charges (to prevent anyone from holding the switch in and keeping the lights off). Now, on leaving the rear door, I can cycle the motion detector by hitting the doorbell, and visitors are greeted by the lights coming on. Or, I have the lights for my normal exit and they turn themselves off. The system works quite well, and I had a similar setup in a house I used to own.

JOSEPH J. SYCZYLO
Sy Enterprises
North Fork, Idaho



Isn't it amazing how a study of our different "consumer needs"—and a little customizing of circuits, delays, interlocks, and interactions—can lead to some very versatile applications? And surprise the heck out of the deer and raccoons, too!—RAP

Robert:

You learned to type the HARD way. I took a typing and shorthand class (only two males in our class!) when I was in the 11th grade of high school. (*No, because I learned in the 4th or 5th grade. Learning skills there are better than in the 11th grade. /rap*) I was thinking those two skills would come in handy when I entered Ohio State University (taking notes during lectures, typing English essays, etc.).

Well, I did quite well in both typing AND shorthand, being "certified" at 125 wpm in both (mechanical typewriters, I might add!). I made one big mistake, however. I didn't continue with the typing and shorthand classes during my Senior year. So, by the time I entered university the following fall, I'd TOTALLY lost my shorthand skills. I DID manage to keep my typing speed up.

Now that I'm much older, I can still do a respectable 80 to 90 wpm in "straight text" on a decent keyboard. I come to a screeching halt, however, when numbers are thrown in.

Thank you, Robert, for all your erudite writing(s). Please don't ever stop!

KARL H. KANALZ

via e-mail

Hey, I'm happy with 30 wpm.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer
Please note NEW e-mail address:
rap@galaxy.nsc.com. The older one at "webteam" seems to be broken.
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